BUILDING A CONCEPTUAL MODEL TO DEFINE THE
F-22 SUPPLY SUPPORT DECISION PROCESS

THESIS

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Steven P. James

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Abstract

The Air Force requires a method to determine the most effective and efficient means of supply support for new weapon system acquisitions. This study is a qualitative research effort that examines this requirement in an environment that embraces interim contractor support for the F-22. A series of six propositions are suggested to incorporate in the supply support decision-making process. A conceptual model is developed from these propositions to describe the process for determining the optimal timeframe for making long term supply support decisions. A systems approach to project management is used as the vehicle for this process, and the F-22 Supply Support Integrated Product Team is the driver. Weapon system stability/maturity is contemplated as one of the input parameters, and a definition of stability is presented. Judgment will be a major factor in the ultimate supply support decision due to the lack of available system tools to accurately predict the most appropriate timeframe. The most important recommendation is that the process of evaluation should begin immediately. Familiarity will increase knowledge and experience as team members are exposed to this emerging concept. Due to the novelty of this topic, this research documents the deficiency in this area and lays a cornerstone for future research.

BUILDING A CONCEPTUAL MODEL TO DEFINE THE F-22 SUPPLY SUPPORT DECISION PROCESS

I. Introduction to the Research

The Department of Defense (DOD) must vigorously compete with other government programs for the funding required to protect its citizens and fulfill its evolving responsibilities. Within the DOD, the sister services vie for limited funding. This competitive environment coupled with changing business practices has forced the Air Force to modify the way it operates. The development and support of the Lockheed Martin, Boeing, Pratt & Whitney F-22 aircraft is no exception to this change of attitudes. The Air Force is assuming less responsibility, while contractors are assuming more. This shift in responsibilities is creating new challenges, such as determining the proper mix of contractor and organic support for Air Force missions. This research focuses on one aspect of the contractor-organic support equation, supply support, in the development and sustainment of the F-22.

Background

The historic Air Force view of weapon system support has been that organic depot activation would begin early in the weapon system life cycle. Air Force depots have been a central figure in supporting major weapon systems beyond their intended service life. This support has included engineering,

technical orders, spare parts procurement, support equipment, technical expertise, and weapon system modifications and overhauls. General McPeak, then Chief of Staff of the Air Force, issued a memorandum on 1 June 1994 that disrupted the traditional role of organic support for the F-22 with this question:

> How much can we reduce the cost of the F-22 program by "privatizing" logistics support?
> - No depots
> - No government held WRM [War Readiness Materials]
> - Rely on JIT [Just in time] spares support from industry
> - No continuing in-house engineering support, etc.
>
> (McPeak, 1994)

Current guidance for acquisition programs such as the F-22 states that "Acquisition programs shall be managed to optimize total system performance and minimize cost of ownership" (DODD 5000.1, 1996). To minimize cost of ownership, "Support concepts for new and modified systems shall maximize the use of contractor-provided, long term, total life-cycle logistics support that combines depot-level maintenance for non-core related workload along with wholesale and selected retail materiel management functions" (DODR 5000.2-R, 1996). The recent bias towards full contractor support for increasing periods of time is intended to increase efficiency by hiring contractors to perform activities at a lower cost than Air Force organizations, without sacrificing effectiveness. A potential area for life cycle cost reduction is supply support.

Supply is possibly the largest element of the support equation in terms of cost. The Air Force defines supply support as:

> Determining requirements, acquiring, cataloging, receiving, storing, issuing, and disposing of secondary items such as spares, repair parts, reparable parts and consumable material. It includes provisioning for initial support and the acquiring, distributing and replenishing of inventory spares and parts and planning for direct and competitive spares procurement. (ESC, 1996)

Provisioning refers to:

> The management process of determining and acquiring the range and quantity of support items necessary to operate and maintain an end item of material for an initial period of service. (ESC, 1996)

Depots play an important role in supply support because depots have traditionally controlled spares procurement; however, the current F-22 support plan delays organic depot activation for at least three years from the conception of the production stage. After this period, the Air Force will incrementally develop organic capabilities over the next five years. These dates were calculated using 100,000 cumulative flying hours as a baseline and projecting that total to be achieved during the 2005 to 2008 timeframe. The caveat to this plan is the support of avionics by the prime contractor through 2013 (F-22 Support Concept Overview, 1997). This change in the supply support concept resulted from the Air Force Materiel Command (AFMC) Reengineered Supply Support Process White Paper findings.

The Supply Support Integrated Product Team (SSIPT) was chartered to examine contractor support and initial spares for acquisition processes. The SSIPT radically redesigned spares support and created a single streamlined process called Interim Supply Support. A major benefit of the ISS process is the sensible elimination of duplicate efforts "through outsourcing some activities formerly accomplished by the government and establishing a partnership

between industry and government" (AFMC RSSP, 1996). The F-22 System Program Office (SPO) responded to the AFMC White Paper by issuing a change proposal that reduced Air Force involvement in this process and limited "government involvement to performance monitoring until the production design stabilizes" (Change Proposal SPO-0156, 1996).

Unfortunately there are no established criteria for determining the stability of a weapon system because this was not a vital concern when the Air Force sustained support responsibility. Furthermore, 100,000 flying hours is an arbitrary baseline for defining weapon system maturity/stability. Additionally, there are no set guidelines for establishing the proper balance of contractor and organic responsibilities. Air Force leadership is taking a "wait and see" approach for determining if, when, and how much supply support responsibility will transfer to the government. The assumption is that a portion of these responsibilities will transfer at some point.

Problem Statement

There are several levels of questions to be examined for this research effort. These include management questions, research questions, and investigative questions. At the top of this question hierarchy is the management question. This question represents a managerial decision. It is the problem that prompts the research. Next are the research questions. These are fact-oriented, information-gathering questions that form the basis for the thesis. Investigative questions are more specific than research questions. Data are gathered to

answer the investigative questions to satisfactorily respond to each research question (Cooper, 1995).

The following is a list of questions arrived at according to the previously mentioned hierarchy. These questions have evolved in response to evaluating the ultimate problem. As previously stated, there are no established criteria for determining the stability/maturity of a weapon system. The intent of this study is to present credible criteria to aid in this process of predicting and assessing stability.

- **Problem Statement:**
  - There is no clear definition of weapon system stability to build into life cycle support decisions for the F-22.

- **Management Question**:
  - What is the best mixture of supply support for the F-22 that optimizes efficiency and effectiveness?

- **Research Question:**
  - When is the weapon system stable/mature enough to make this decision?

- **Investigative Questions:**
  - What process should be used answer the research question?
  - Who should be the decision authority for this process?
  - What parameters should be used to define this process?
  - What is the definition of weapon system stability?

- **Thesis Objective:**
  - This thesis will develop a conceptual model that describes the decision-making process that should be used to determine when to evaluate the optimum life cycle supply support posture for the F-22.

This thesis does not attempt to answer the management question. The research question's only endeavor is to determine when this decision should be made concerning supply support responsibilities.

Methodology

The first step in developing the methodology is to investigate and choose an accepted modeling process for this research. A qualitative research design was chosen to provide the framework to verify and validate this process. This qualitative design will shape the data collection, data analysis, and conclusions. This thesis is an exploratory effort to answer the research question and provide a foundation for future studies. A qualitative methodology appropriate for this type of thesis is explained in further detail in Chapter III.

Scope and Limitations

There are severe limitations to this research since there are no established guidelines for evaluating weapon system stability. Additionally, decisions are currently being made that will greatly influence answers to the questions of if, when, and how much supply support responsibility will transfer to the government. Once again, this research does not look at what constitutes the best mixture of contractor and organic supply support. But, since no one knows what criteria will be used to make this decision, no one definitively knows the best decisions to make now to increase efficiency and effectiveness over the F-22's life cycle.

The scope is to establish some boundaries along the production and sustainment timeline to help resolve this problem. Efficiency and effectiveness are conflicting factors that will be influenced by risk management and trade-off analysis. These factors and influences can create vast differences between the ideal (effective) solution and the fiscally constrained (efficient) solution. An

assumption is that credible data will be available from the contractor to make this decision. Another assumption is that the entity responsible for this decision will have the authority to select the best option regardless of politics. The most important assumption is that there is an opportune period in which to make this decision that will result in cost and performance benefits for the Air Force.

Management Implications

This research will establish some basic criteria for evaluating the stability of major weapon systems. These criteria are necessary to make aircraft development and support decisions in this new environment of interim contractor support (ICS) vice traditional depot concepts. As a planning tool, definition of aircraft stability/maturity should increase both effectiveness and efficiency by determining when to decide the contractor-organic support mixture. Specifically, supply support considerations are important because the contractor will control the entire supply support process including Contractor Operated and Maintained Base Supply (COMBS). Assuming it is advantageous for the Air Force to transfer responsibilities at some point in time, a method must exist to determine when to make this decision to exploit effectiveness at the lowest possible cost. Furthermore, this method will result in a projected decision-making timetable to incorporate into the contractor's development and production processes. Knowing the minimum duration of ICS should incentivize the contractor to build a more reliable and maintainable weapon system since it will be in the contractor's best interests. Although this effort is aimed at the F-22, findings should provide a foundation for AFMC to build upon in the acquisition of future weapon systems.

Summary

There is a convincing need for defining weapon system stability/maturity since the Air Force now relies on contracted supply for an initial support period. The problem is that no definition currently exists to determine how long this period should last. The Air Force wants to make the best life cycle decision for this schedule considering cost and performance factors. Now that this need has been established, the remaining four chapters support this thesis by reporting on the current status, the research design, the analysis of data, and the findings. These chapters are organized as follows:

Chapter II. The literature review documents the deficiency in this area because little work has been accomplished on this subject in the past. This chapter includes prevailing guidance and a brief overview of the acquisition environment. It also presents an F-22 timeline, current as of December 1997, to identify major milestones that will serve as guidelines during this process.

Chapter III. This is the most important chapter because the methodology drives the process of collecting and analyzing data. The process dictates which data are collected and how those data are analyzed. It also impacts the method for reporting the findings. The validity of the research findings begins with the research design. The methodology was briefly discussed earlier in this chapter.

Chapter IV. The research identifies the criteria for the stability/maturity definition. These criteria are the parameters for identifying stability/maturity in a major weapon system, for the purpose of developing a decision-making schedule for determining long-term supply support.

Chapter V. The conclusions summarize the thesis findings and present suggestions for further research.

II. Literature Review

Introduction

This thesis identifies parameters to define the stability and maturity of a weapon system, specifically the F-22. This definition is important because it will provide a tool for decision-makers to recognize the most favorable timeframe to determine the proper balance of contractor and organic supply support. Without a stable/mature design, it is difficult to determine the most beneficial cost and readiness support combination for the Air Force. Valid and reliable performance and cost data, obtained from a mature subsystem design, must be received from the contractor to make this significant decision.

Unfortunately, there is little guidance concerning the stability/maturity of a new weapon system, and this information is vital for the purposes of determining the proper blend of efficiency and effectiveness in the area of supply support. Due to the lack of available resources, this chapter focuses on documenting the deficiency of defining stability or maturity. This chapter defines the applicable terms and concepts and describes the acquisition and sustainment environments. Next, the need for a definition of stability/maturity is highlighted. Finally, the F-22 concept and the projected acquisition and support timeline are produced.

Concepts and Environment

Efficiency versus Effectiveness. The DOD Logistics Mission is "to provide responsive and cost-effective support to ensure readiness and

sustainability for the total force in both war and peace" (DOD Logistic Strategic Plan, 1998). The acquisition objective echoes the logistics mission:

> The primary objective of the defense acquisition system is to acquire quality products that satisfy the needs of the operational user with measurable improvements to mission accomplishment, in a timely manner, at a fair and reasonable price. (DODD 5000.1, 1996)

The essential elements of these definitions are cost (efficiency) and readiness (effectiveness). The first of these elements, cost, is embodied in a concept called cost as an independent variable (CAIV). CAIV is based on a philosophy requiring acquisition managers to recognize fiscal constraints to trade off performance and schedule early in the acquisition cycle (DODD 5000.1 and DODR 5000.2-R, 1996). The second element, readiness, is the overriding factor because peacetime readiness and wartime utilization requirements must fulfill national security objectives. Supportability is used here to address readiness because of its direct correlation to the area of supply support.

"Supportability is the degree to which system design characteristics and planned logistics resources meet system peacetime and wartime requirements" (DOD Handbook 502, 1997). Supportability includes the notion of cost constraints and performance measures to assess whether the system design meets the intended operational usage. The system design is considered complete when it demonstrates its operational suitability and affordability. It is important to view supportability from both the total system's aggregate and disaggregate points of view. For this reason, cost, equipment readiness, and personnel constraints "should always be considered as part of the total system design process because of their ability to affect system supportability" (DOD

Handbook 502, 1997). A basic understanding of the DOD acquisition concept is required to determine the proper efficiency/effectiveness balance.

Acquisition Development Cycle. Every acquisition development process is predicated by a need. In the DOD, this takes the form of a mission need statement (MNS). Next, an operational requirements document (ORD) describes how the MNS is achieved. Approval of these two documents is necessary to enter the acquisition development cycle. This process is outlined in DOD Handbook 502, DOD Directive 5000.1, and DOD Regulation 5000.2-R.

Once the need has been established, the milestone decision authority (MDA) determines whether to enter Phase 0, the concept exploration (CE) phase. Performance requirements and supportability issues are key concerns at the onset because 70 percent of the cost decisions are made before leaving Phase 0. Costs are important because there is a static amount of funding available to address the life cycle costs of a new weapon system. Figure 1 illustrates cost decisions and phases.

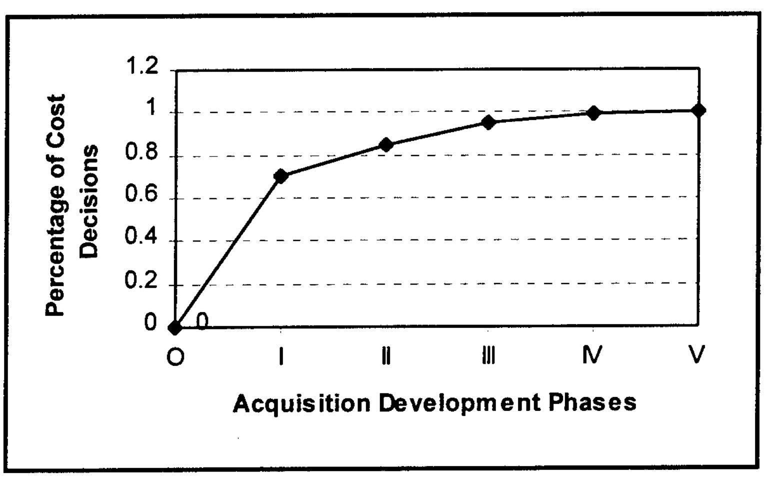

Figure 1. Life Cycle Cost Decisions (Scott, 1998).

An equally important cost consideration is the distribution of cost expenditures. Operations and support consume 60 percent of the life cycle costs of a weapon system. Figure 2 depicts these expenditures.

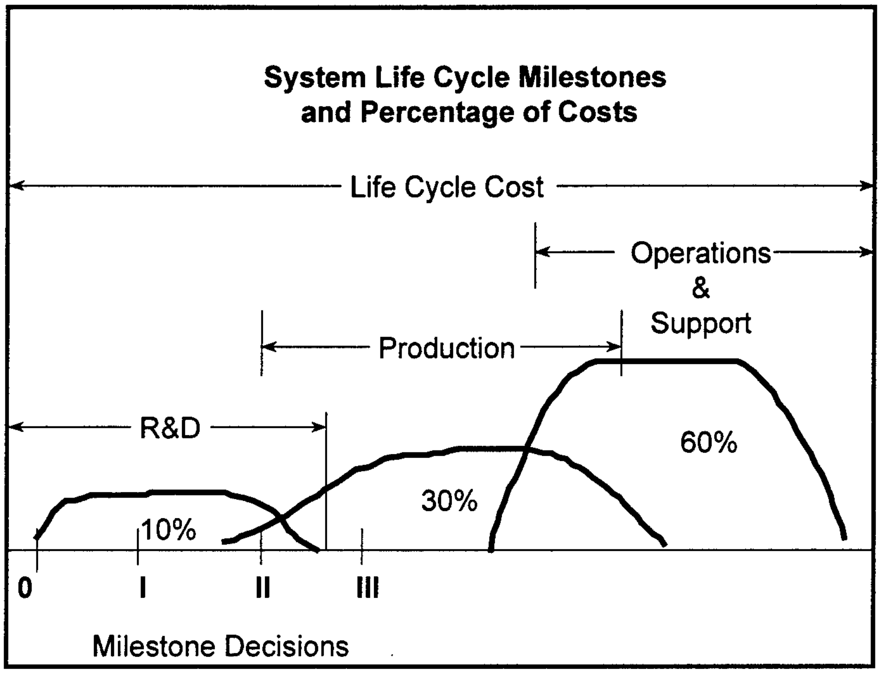

Figure 2. Life Cycle Expenditures (Scott, 1998).

Costs are more easily quantified than readiness and can potentially cancel an acquisition program, but as mentioned previously, meeting the minimum readiness requirements prevails over the importance of life cycle efficiency.

<u>IWSM versus PMRT.</u> A major distinction in past and present program management is Integrated Weapon System Management (IWSM). IWSM is a cradle-to-grave, life-cycle approach to managing major Air Force weapon systems. It is managed by AFMC and is outlined in AFMCP 800-60. The main point of IWSM is that there is a single manager responsible for all aspects of

acquisition and support throughout the weapon system's life cycle. The maintenance concept is also important because it becomes the foundation for all support planning (ESC, 1996). Weapon system management was previously managed by two separate commands, Air Force Systems Command (AFSC) and Air Force Logistics Command (AFLC), before they merged to form AFMC in 1992. AFSC was responsible for acquiring a weapon system and AFLC was responsible for supporting it in the field. Program Management Responsibility Transfer (PMRT) was the process used to transfer responsibility between these two commands. A common phrase used to describe this relationship is that AFSC would "throw the aircraft over the fence" to AFLC. This phrase was used because the two commands were not integrated in their focus on weapon system management. The following is an example of the paradigm that has resulted from consolidated management of the acquisition cycle.

One expert has proposed that the military should wait until it has a "substantially stable design" before the provisioning and support structures are procured (Youther, 1996). He attributes the historical reason for rushing into organic support to the mission needs associated with the Cold War threat. While Youther's comments are probably not new, it is certain that eliminating initial provisioning would have been impossible in the disjointed environment of "throwing the aircraft over the fence." He also provides some loose guidelines for a new provisioning process. First, provisioning data should be delayed until the early stages of full-rate production. Data should be accepted incrementally as the system matures, when more accurate data would be available. Second,

interim contractor support (ICS) would be responsible for support during the delay in development of organic capabilities (Youther, 1996). This new way of thinking is a direct descendent of the IWSM approach to managing the acquisition cycle.

Design versus Performance Objectives. A recent trend in government contracting practices is the shift from design to performance specifications. Design specifications subject the government to general responsibility for errors and deficiencies because the contract states in precise detail how the work is to be performed. Performance specifications are less precise. They tell the contractor what needs to be accomplished, not how to accomplish it. In this type of contract, the contractor accepts responsibility for the design, engineering, and achievement of the requirements (Arvanas, 1994). Performance objectives are important because the government is outsourcing more tasks and also outsourcing the responsibility, or risk, of these tasks. In the acquisition environment, support requirements must be stated as performance requirements. These requirements must relate to the operational effectiveness, suitability, and life cycle cost reduction of the system (DODR 5000.2-R, 1996). Section 6 of DOD Handbook 502 describes how to express performance requirements as performance terms to develop measurable support requirements.

Contractor Support. Outsourcing and commercial practices are directed by DODR 5000.2-R, which states that "commercial and non-developmental items shall be considered as the primary source of supply" (DODR 5000.2-R, 1996).

Furthermore, "support concepts for new and modified systems shall maximize the use of contractor provided, long-term, total life-cycle logistics support" (DODR 5000.2-R, 1996). Contractor support is a comprehensive term that relates to planned contractor responsibility for support of a system, subsystem, equipment, or end-items (Miceli, 1998). Interim contractor support (ICS) and contractor logistics support (CLS) are the types of contractor support relating to the subject of this thesis.

ICS is intended to be utilized during temporary periods with unstable system design or support equipment. New weapon systems are prime candidates for ICS because there are insufficient logistics data to support decision-making. Contractor support is supposed to bridge the gap between the time of first aircraft delivery until a depot repair source is selected. CLS is used to augment or replace organic depot activities (Miceli, 1998). ICS and CLS are related because ICS is intended to support the weapon system until the decision is made to choose CLS or organic depot capability. If CLS is chosen, it implies contractor management of the weapon system for the intended life-cycle.

Need For Stability Definition

Many official military documents call for stability and maturity in the defense acquisition program. Several examples are presented here to establish the need for this valuable information; however, the reader will notice the lack of guidance for implementation--not once is a definition of these terms included. The terms stability and maturity are widely used throughout the Air Force but are not well defined or understood. In fact, there has never been a clear definition for

any major weapon system that fully captured this concept (Alexander, 1998). This section begins with definitions of stable and mature since stability and maturity are not officially defined. Stable means “resistant to sudden change of position or condition; maintaining equilibrium; consistently dependable” (American Heritage, 1985). Mature means “fully developed” (American Heritage, 1985). Even these definitions lack the clarity desired for this situation. Applied to weapon system design and performance, it appears that stability refers to a system that performs consistently with little variability.

Program and Production Stability. The Defense Acquisition Directive, DODD 5000.1, states that policies concerning defense acquisition shall be governed by the following principles: "(1) translating operational needs into stable, affordable programs, (2) acquiring quality products, and (3) organizing for efficiency and effectiveness" (DODD 5000.1, 1996). Furthermore, DODD 5000.1 calls for program stability as part of the translation into stable and affordable programs. It states:

> Once DOD initiates an acquisition program to meet an operational need, managers at all levels shall make program stability a top priority. To maximize stability, the Components shall develop realistic long-range investment plans and affordability assessments. The Department's leadership shall strive to ensure stable program funding throughout the program's life-cycle. (DODD 5000.1, 1996)

In this example, the call is for program stability, which appears to refer primarily to life-cycle costs and funding. But what does the term "stable" mean? Another example comes from DOD Regulation 5000.2-R concerning manufacturing and

production. Although not applicable to major weapon system programs, DODR 5000.2-R states:

> Full rate production of a system shall not be approved until the system's design has been stabilized, the manufacturing processes have been proven, and the production facilities and equipment are in place. (DODR 5000.2-R, 1996)

Design stability is required to begin production, but once again, what does it mean to have a stable design?

The Integrated Logistics Support Handbook calls for stability in the areas of provisioning and consignment. Consignment refers to the transfer of management responsibility for subsystems or equipment. A stable system components configuration is required before beginning provisioning production. Also, a stable item design is appropriate for the purposes of Interim Release for long lead-time items. Interim Release refers to items that require a longer period to manufacture than is available for the provisioning process. Finally, maturity indicators should be addressed when considering consignment (ESC, 1996). But, because the terms stability and maturity are never explained, definition is left to the disposition of the individual.

Design Stability. DOD Regulation 5000.2-R calls for design stability on several occasions. In the area of support resources, this regulation says:

> Support resources such as operator and maintenance manuals, tools, support equipment, training devices, etc. for major weapon system components shall not be procured before the weapon system/component hardware and software design stabilizes. (DODR 5000.2-R, 1996)

Additional guidance is provided through the general factors listed as stipulations to determine a mature design. The program manager is required to establish

reliability, maintainability, and availability activities early in the acquisition cycle. Reliability requirements "shall address" mission and logistic reliability. Maintainability and availability requirements "shall address" servicing, preventive, and corrective maintenance, and system readiness, respectively. Furthermore:

> The PM shall plan and execute reliability, maintainability, and availability design, manufacturing development and test activities such that equipment used to demonstrate system performance prior to production reflects the mature design. (DODR 5000.2-R, 1996)

Once again, how can the design be mature when there is not sufficiently reliable data to make this determination? Besides, even with sufficient and reliable data, the system may not be mature, or the activities established early in the acquisition may not be accurate reflectors of maturity. Another complication is the different rates at which components and subsystems mature within the total system.

Component and subsystem maturity is important because the determination to transfer from contractor to organic supply support will not be made at the weapon system level. "As reliability experience is gathered and assessed for demand stability and reliability performance, management of those items/ subsystems deemed stable by the SSIPT will transfer to the government ICP [Inventory Control Point]." The SSIPT is required to create a transition plan and schedule to accommodate the transfer responsibility if and when transfer occurs (AFMC RSSP, 1996).

F-22 Concept and Timeline

Concept. The F-22 falls under the IWSM concept of program management, with contractor support utilized to the maximum extent possible. Both ICS and CLS are currently planned. The maintenance concept is primarily two-level, meaning that the majority of aircraft maintenance will be accomplished on the aircraft, with no off-aircraft maintenance support at the base level. Repairs beyond the capability of flight line maintainers will be accomplished at a depot-level facility or parts will be thrown away at the base level. The support concept is for the prime contractor to handle the majority of support issues except for on-aircraft maintenance. This support includes base-level supply support services. Figure 3 lists general contractor support services.

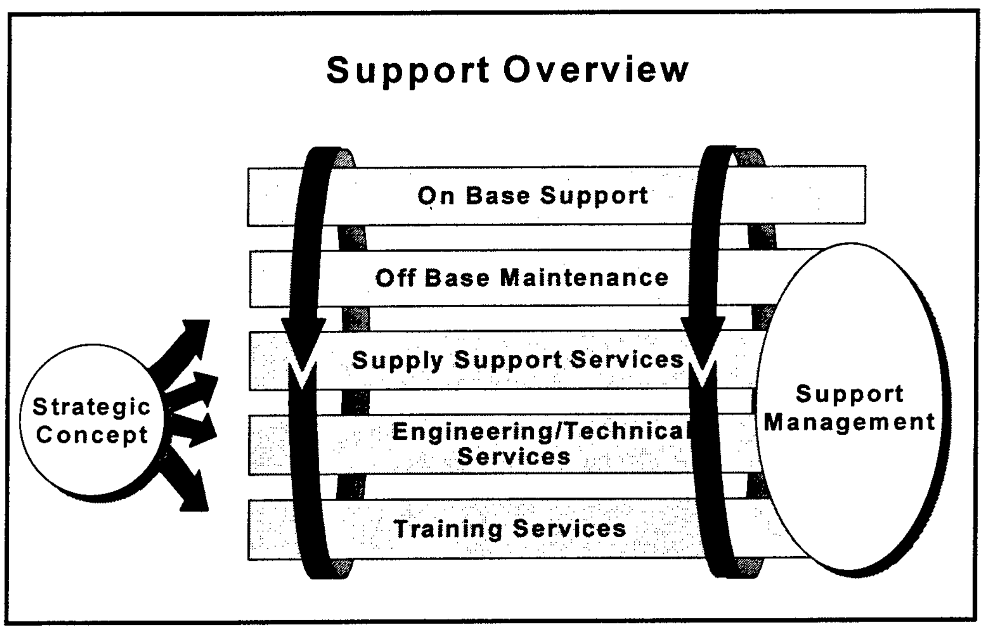

Figure 3. F-22 Support Concept (F-22 ILSS, 1997).

A transition plan is required for those items deemed stable and worthwhile to transfer to organic supply support, but this plan has not yet been created, nor is it currently scheduled for creation.

Performance Objectives. The primary stated performance objective is the mission capable (MC) rate. The MC rate is a measure of aircraft availability, and Air Combat Command (ACC) has assessed a minimum goal of 85 percent (F-22 ILSS, 1997). This measure is normally applied at both the squadron level and to the total fleet. It means that at least 85 percent of the aircraft are expected to be available and capable of performing their mission. The remaining 15 percent are divided into standards for maintenance and supply. Aircraft not available for maintenance reasons should not exceed 8.5 percent, and aircraft not available for supply reasons should not exceed 6.5 percent. If both rates are within limits, the MC rate will be achieved. Reliability and maintainability standards will be applied at the subsystem and component levels, but these are important mainly in how they affect overall availability, or the MC rate.

Timeline. The F-22 is currently in Phase II, Engineering Manufacturing and Development (EMD). Five events establish a timeline to steer this process of defining stability. These events include: the decision to enter Low Rate Initial Production (LRIP); the decision to enter Milestone III, High Rate Initial Production (HRIP); Initial Operational Capability (IOC); 100,000 total flying hours; and the production effort completed. The first major landmark is the decision to enter LRIP. LRIP is limited to a maximum of ten percent of the total aircraft planned for

production, and is scheduled for the latter part of fiscal year 1998 or the beginning of fiscal year 1999. The uncertainty of the exact date is due to the politics of this expensive acquisition program. The Milestone III decision to enter HRIP should take place in 2003. This decision is important because it signifies official entrance into Production, Phase III of the acquisition development cycle. The next notable event is IOC, which is defined as the first operational squadron. This event is scheduled to occur in December 2003. The achievement of 100,000 total flying hours is estimated for 2008. This is when the F-22 is expected to achieve stable design, according to the F-22 SPO's current definition of stability. Finally, production will cease in 2013 when the final F-22 rolls off the production line (F-22 ILSS, 1997). Each of these events is subject to change if the acquisition cycle is slipped or the number of aircraft is decreased. Figure 4 provides a visual display of these events and projected dates.

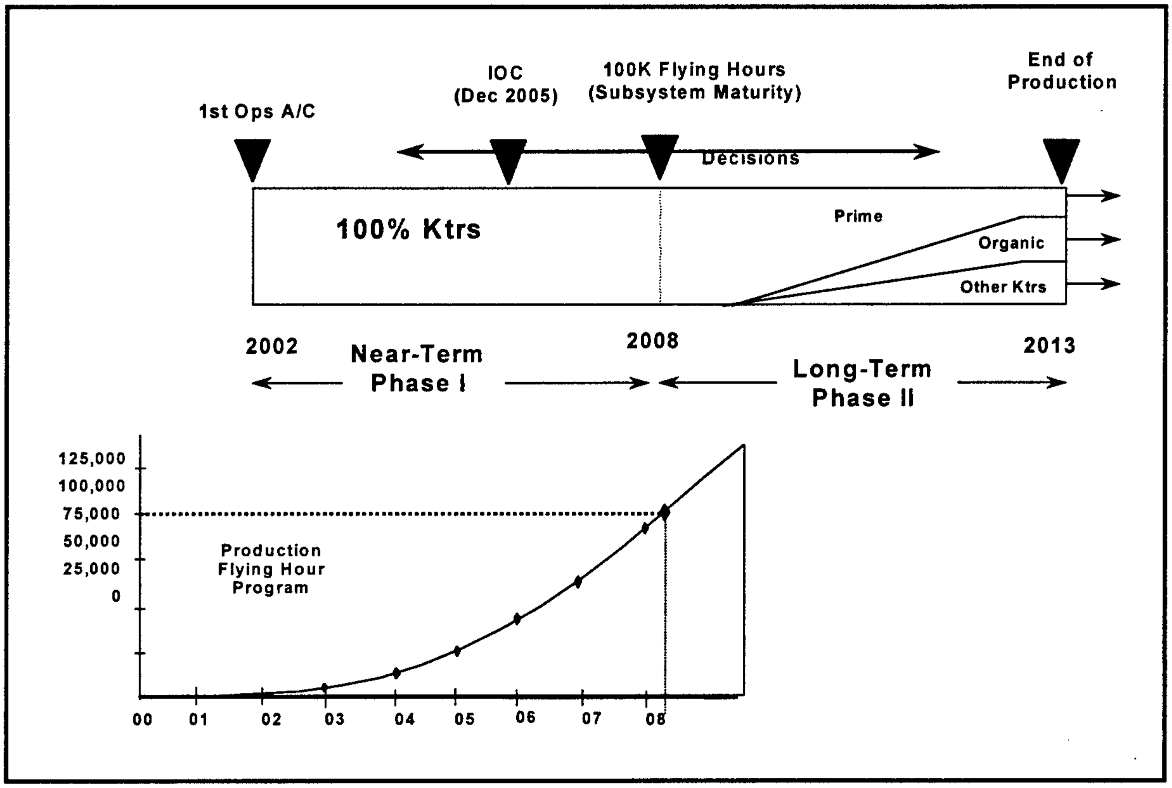

Figure 4. F-22 Timeline (F-22 ILSS, 1997).

Summary

This chapter has described the acquisition environment, to include a brief overview of IWSM and the shift towards increasing contractor support. Due to the lack of guidance in defining stability, this chapter has documented the deficiency in this area, and has shown the need for this definition in reference to DOD guidance and the needs of the F-22 SPO. Without an accurate definition of design stability it will be difficult to determine, with foresight, the most effective and efficient means of supply support for the remainder of the F-22's life cycle.

III. Research Methodology

Introduction

The motivation for this research is to answer the initial question of, "When is the product (F-22, subsystem, or part) stabilized/mature enough to switch to Air Force spares procurement?" This question is based on the recommendation from the AFMC Supply Support Integrated Product Team (SSIPT) that the Air Force should rely upon contractor supply support until the product stabilizes/ matures. The problem rests in the absence of guidelines to evaluate stability/maturity; guidelines or a model need to be developed so the F-22 SPO can determine stability/maturity, and therefore, predict when to transition to the determined mixture of contractor and organic supply support. It is important to note that the following hierarchy of questions is currently unknown:

- What will be the final mixture of contractor and organic supply support?
- When should the decision be made to transfer responsibility to the Air Force?
- It has been predetermined that this decision should be made when the design is stable; however, when is the design stable?
- What are the parameters that define stability and maturity?
- What is the transition plan for transferring supply support responsibilities?

The answer to each of these questions is essential to understanding the holistic problem. Currently, the only known answer to these questions is that no organic spares procurement or support will take place until the weapon system design stabilizes. Decision-makers have not determined the support mixture or the

transition plan. The following figure depicts a simplified picture of this interrelated process.

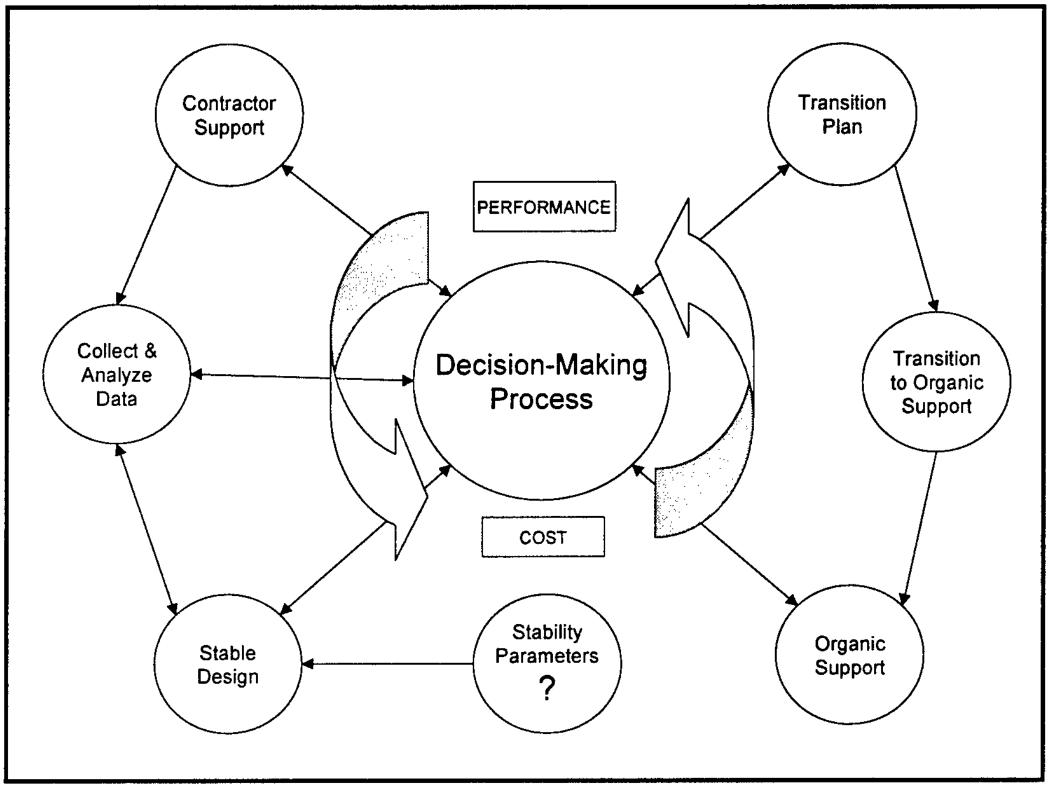

Figure 5. F-22 Supply Support Process.

Figure 5 displays the decision-making process as the central theme to the process of determining the ultimate supply support concept. It begins with total contractor support (top left) and ends with an unknown portion of organic support (bottom right). The central circle, the decision-making process, refers to the decision of whether to transfer responsibilities to the Air Force. The primary contractor supports the weapon system initially and provides performance data to the Air Force to determine effectiveness. These data are used to decide if there is a stable design and as inputs to the decision-making process. The contractor's

ability to provide supply support will not be fully portrayed through the data that are collected and analyzed, which could be caused by corrupted data or by intangibles that are not captured in the data. Data may be corrupted because it is not input properly or because it was not accurate in the first place. The double-sided arrow reflects the two-way relationship between the contractor and the decision-making process.

Next, a stable design is concluded through the stability parameters and the data supplied by the contractor. The data help to verify stability; however, the correct parameters must first be chosen to determine which data are important. The stability of the design will play an important role in the decision-making process by offering a timeframe for making this decision. Another factor in the decision is the transition plan because of the costs involved to transition supply support responsibilities and the learning curve period. Finally, organic support will affect the decision-making process because of the cost and effectiveness trade-offs between the contractor and the government. The transition plan and organic support are similar in their relationships with the decision-making process. There are costs involved with implementing a transition and there may also be temporary lapses in effectiveness. Likewise, the Air Force's ability to provide organic supply support should also be considered in this equation. Cost and performance are primary factors throughout this entire concept.

The three circles in the lower left-hand corner of Figure 5 depict the focus of this research: Data, Stable Design, and Stability Parameters. It is important to reemphasize that the focus of this research should not be the only consideration

for the decision, but only a determination of when to make the decision. Other factors include contractor support, the transition plan, and organic support. Now that the concept has been presented, the next step is to outline the research design.

Research Design

Choosing a Qualitative Process. "Qualitative methods can be used to uncover and understand what lies behind any phenomenon about which little is known" (Strauss & Corbin, 1990). Additionally, one of the main reasons for choosing a qualitative study is to explore a topic that not much has been written about (Creswell, 1994). These statements certainly apply. Little literature is available on this subject as outlined in the literature review. Furthermore, the aim of qualitative research is discovery. The preliminary focus is broad and open-ended, allowing important patterns and meanings to be discovered (Maykut & Morehouse, 1994). The researcher's goal is to explore a new area and build a theory about it. These notions of exploration and discovery fit well with the task of identifying parameters to define weapon system stability. Another important point is that qualitative data can lead to new integrations by helping the researcher to generate or revise traditional frameworks (Miles & Huberman, 1994). Finally, a qualitative study is an inquiry process to increase understanding of a social or human problem (Creswell, 1994). The problem is to develop a method for making multi-billion dollar decisions on how to support a weapon system when no guidelines are established to make that decision. This thesis presents a better understanding of this problem.

Components and Characteristics. At its most elementary level, there are three major components of a qualitative research effort. These components are the gathering of data, analytic and interpretive procedures, and the written and verbal reports (Strauss & Corbin, 1990). The initial data were compiled as a result of the literature search (see Chapter II). As for the art of interpretation, "in the social sciences there is only interpretation. Nothing speaks for itself " (Denzin & Lincoln, 1994). The qualitative researcher, the key element in the inquiry process, is the discoverer, explorer, interpreter, and spokesperson. The inductive process is essential to analysis and interpretation. Inductive research means the "researcher builds abstractions, concepts, hypotheses, and theories from details" (Creswell, 1994). The flow of the written report cannot be decided until the systematic process has been resolved for performing this qualitative study.

In addition to the components of a qualitative research effort, there must also be some general guidelines for what constitutes qualitative research. Table 1 displays the six basic characteristics of a qualitative mode of inquiry (Creswell, 1994):

Table 1. Basic Characteristics of Qualitative Research.

1.	**Process** is the primary concern
2.	Interested in **Meaning**
3.	**Researcher** is the **Primary Instrument** for data collection and analysis
4.	**Fieldwork** is typically involved
5.	Data display is **Descriptive** using words and pictures
6.	Process is **Inductive**

These characteristics are explained in more detail in the next subsection; however, it is necessary to mention fieldwork and how it was accomplished in this study. Fieldwork was accomplished as a combination of my experience as a maintenance officer at the field- and headquarter-levels, inquiries to the F-22 SPO, and research accomplished for the literature review.

Methodology Alternatives. Two methodologies fit well with this study. Miles and Huberman proposed the first methodology (Miles & Huberman, 1994). Their qualitative methodology is an iterative process comprised of collecting data, reducing the data, displaying the data, and making conclusions (see Figure 6).

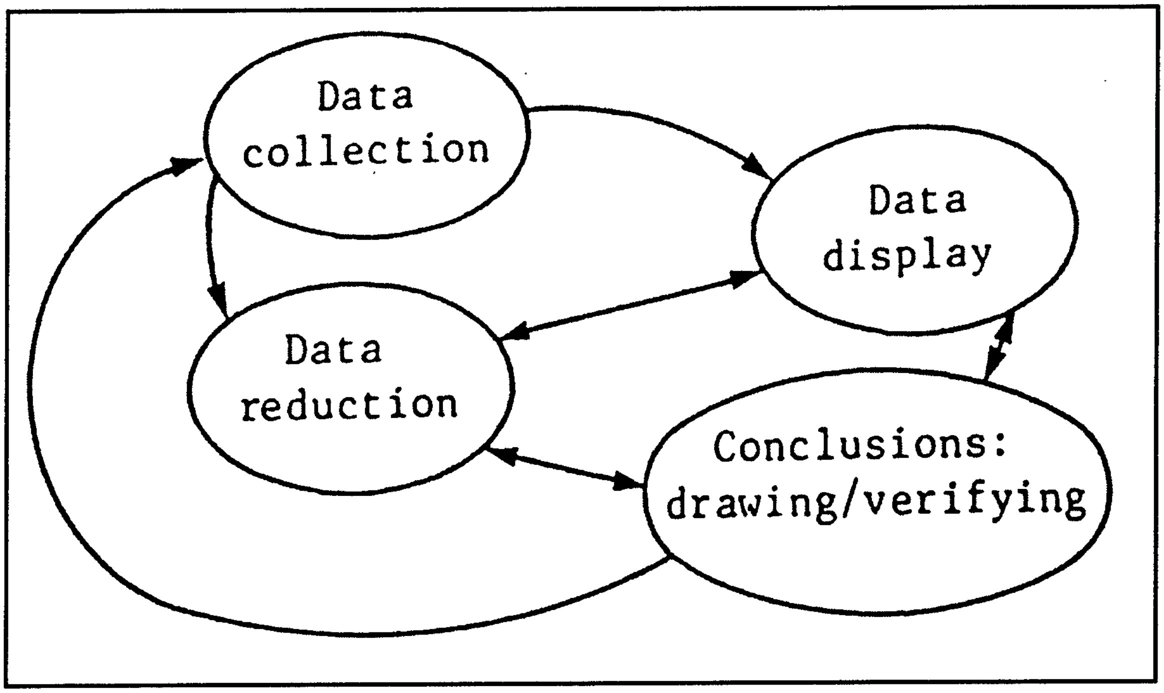

Figure 6. Interactive Research Model (Miles & Huberman, 1994).

Qualitative data have a quality of "undeniability" because words are more convincing than pages of summarized numbers. Displaying data is the central theme for this methodology due to its ability to present a systematic visual format to aid the user in making valid conclusions and taking the required actions. The research and analysis processes for this methodology are oversimplified; consequently, a more explanatory methodology proposed by Maykut and Morehouse was also studied.

Maykut and Morehouse emphasize eight areas in their model, adopted from Merriam, 1988 (Maykut & Morehouse, 1994). These areas capsulate the previous discussions of qualitative studies. Table 2 summarizes these areas:

Table 2. Qualitative Research Elements.

1.	**Exploratory and Descriptive Focus**
2.	**Emergent Design**
3.	**Purposeful Sample**
4.	**Data Collection in the Natural Setting**
5.	**Emphasis on the "Human-as-Instrument"**
6.	**Qualitative Methods of Data Collection**
7.	**Inductive Data Analysis**
8.	**A Case Study Approach for Reporting**

As mentioned previously, the focus of the research is to explore some uncharted territory. The design is emergent because it evolves over time. A purposeful sample is self-explanatory in that the researcher must choose a sample that fits well with the research focus. Also, data collection should be accomplished in a natural setting as opposed to a laboratory. Once again, tremendous emphasis is placed on the 'human-as-instrument' because the researcher must collect and interpret the data. Data collection is performed through qualitative methods of observation, interview, and relevant documents. The data analysis is primarily inductive and is an ongoing research activity. This process involves broadening or narrowing the focus of inquiry. "What is important is not predetermined by the researcher." Finally, the case study approach refers to a rich, detailed narrative. Figure 7 shows how these areas are integrated to achieve a qualitative research design:

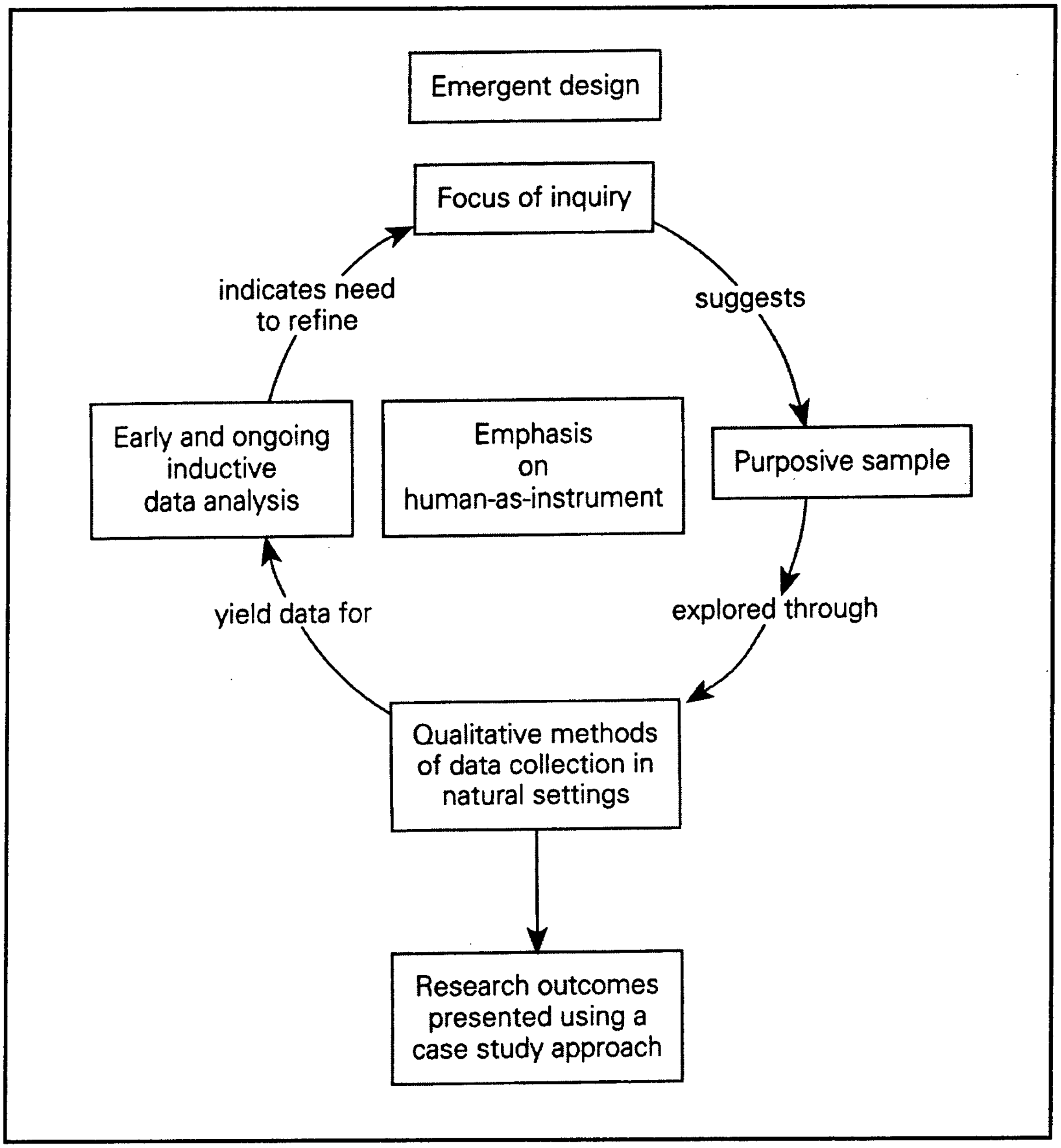

Figure 7. Qualitative Research Model (Maykut & Morehouse, 1994).

A Case Study Approach. I have chosen to modify Maykut and Morehouse's qualitative research design process by adding Miles and Huberman's data display to the case study approach. This results in the bottom block of this model having two inputs: data displays and a case study approach

(see Figure 8). This creates a better qualitative model by integrating the strengths of each.

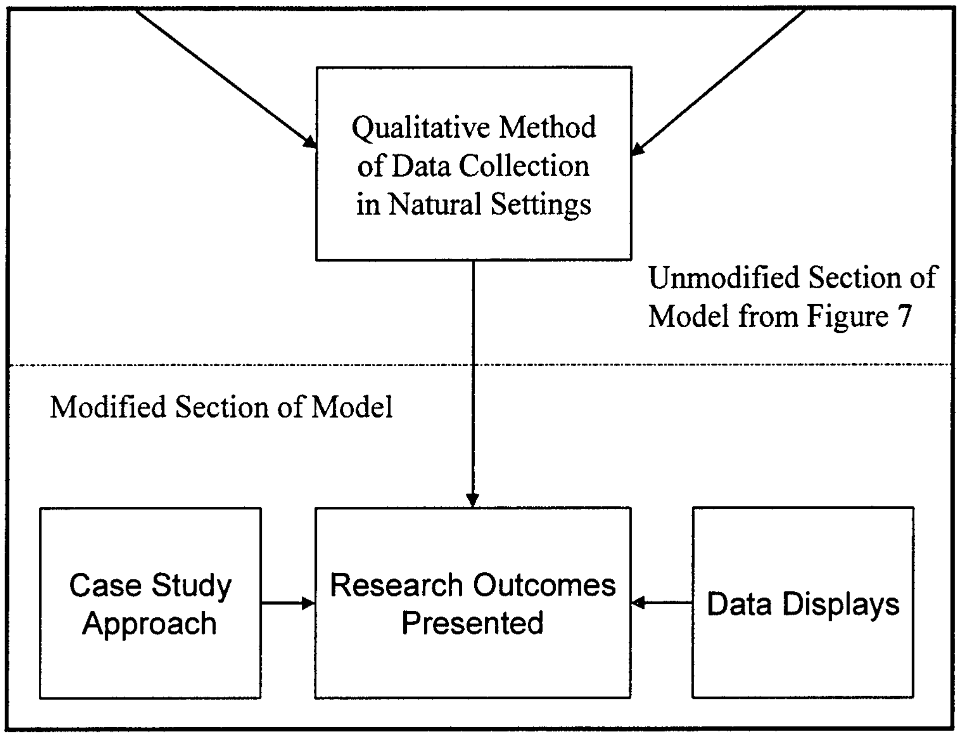

Figure 8. Integrating the Two Models.

<u>Data Collection and Analysis.</u> Data collection was accomplished in Chapter II; however, these data are not sufficient to accomplish the thesis objective, which is to develop a conceptual model that describes the F-22 supply support decision-making process. Additional data collection centers on project management. Project management is based in systems theory and it uses cost, schedule, and performance to evaluate the success of a project. These criteria are suitable for this problem, in which the goal is to determine the schedule based on cost and performance factors. The data are analyzed and a series of six propositions are suggested during the process of developing the model.

Each of these propositions represents a facet of the model, and consequently, the model will change if any of these propositions are modified or deleted. The propositions are integrated to form the conceptual model located at the end of Chapter IV. This model will evolve as the acquisition cycle progresses and more certainties are known.

Summary

This chapter has presented the qualitative research methodology that will be used for this study. The focus is exploratory and the design is constantly emerging. This type of methodology fits well with this relatively undocumented problem of defining stability of the F-22, in order to make future decisions concerning the supply support posture. The next step is to finish applying this design through analysis, interpretation, and reporting the findings.

IV. Analysis and Findings

Introduction

This chapter addresses the investigative questions that relate to the research problem of deciding when the weapon system is stable/mature enough to determine the optimum mixture of supply support:

- What process should be used answer the research question?
- Who should be the decision authority for this process?
- What parameters should be used to define this process?
- What is the definition of weapon system stability?

It examines the data gathered and analyzed throughout this research, using a research design that integrates two qualitative models. The findings are presented in a case study format, with an emphasis on data display. The discussion and examples in this chapter relate primarily to the military since this is the environment of the problem being researched, but simple, common examples are also given to clarify elements of this presentation. The project management discipline is employed in the foundation of the analysis; however, the intent of this research is not to regurgitate a textbook on project management, but to explain this concept in enough detail to relate it to the problem in question. The researcher develops a series of propositions that represent elements of the conceptual model. These elements are integrated to form the F-22 model illustrated in Figure 17.

Project Management Focus

Project management is an outgrowth of systems management, which is "a management approach that attempts to integrate and unify scientific information across many fields of knowledge." Project management is the art of planning, scheduling, directing, and controlling available resources to achieve the specific objectives of a project. Project management has two primary functions. The first is project planning. Project planning involves defining work requirements, defining the quantity and quality of work, and defining the necessary resources. The second function is project monitoring. Responsibilities under the monitoring function include tracking progress, comparing the actual and predicted outcomes, analyzing the impacts, and making adjustments (Kerzner, 1998). Table 3 lists these functions and their activities.

Table 3. Functions of Project Management (Kerzner, 1998).

Project Planning	Project Monitoring
Define Work Requirements	Track Progress
Define Quantity of Work	Compare Outcomes
Define Quality of Work	Analyze Impacts
Define Necessary Resources	Make Adjustments

This brief description of project management provides a starting point for understanding the myriad of responsibilities and skills required for this complex endeavor.

Systems Theory. "Systems theory attempts to solve problems by looking at the total picture, rather than through an analysis of the individual components" (Kerzner, 1998). It can be easy to concentrate too intently on the details of one aspect of a problem and completely miss an obvious answer or limitation within the system. The boundary line is an essential element in defining the system because it is the interface between the system and its environment. Boundaries are permeable and flexible, and they depend on feedback for stability. The environment includes anything outside of the decision maker's control that affects the system. Classification of the two basic types of systems deals with the way a system interacts with its environment. A closed system has no interchange with its environment, whereas an open system interacts with its surroundings (Kerzner, 1998). The system definition depends on the users, environment, and the ultimate goal, and the boundary dictates whom or what is included.

A prisoner of war (POW) in solitary confinement is an example of a closed system. The POW's boundary extends no further than himself since there is no communication with any other persons. In contrast, a family can be defined as an open system. It may consist of grandparents, parents, and children, or simply a husband and wife. Regardless of the makeup, a family interacts outside of its immediate members. Interactions at work, school, church, and the local neighborhood are all within the system boundaries because of influences on family behavior and decisions. Figures 9 and 10 depict these system examples.

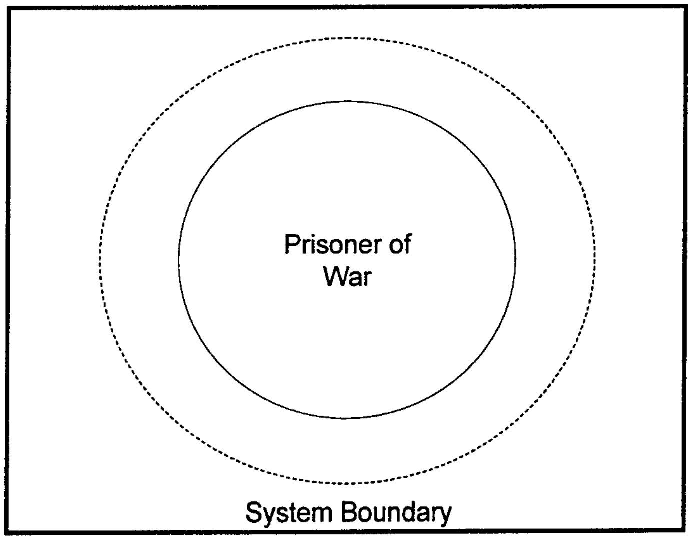

Figure 9. Example of a Closed System.

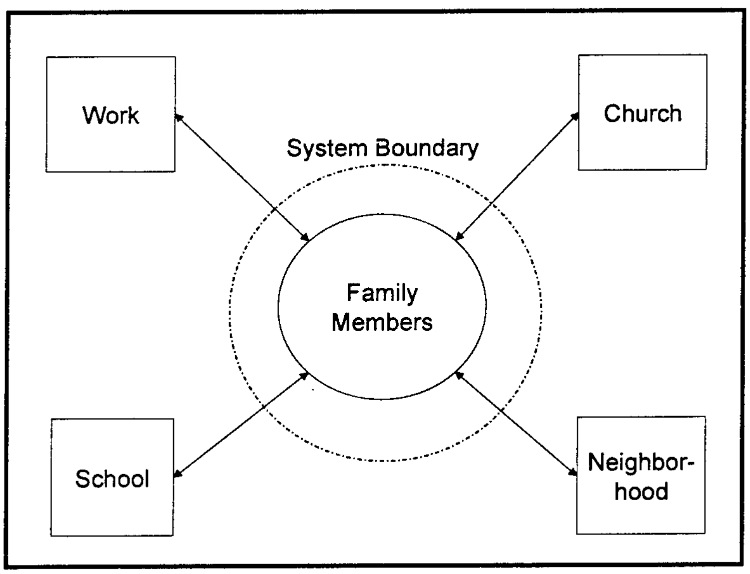

Figure 10. Example of an Open System.

These are simple examples, but the boundaries become more important as the system becomes more complex. An every day decision such as which investments to chose for retirement can become complicated depending on where the boundary is established. The system for this decision could include a computer and software, spouse, friends, financial experts and institutions, the

Wall Street Journal, investing publications, personal experience, intuition, and even prayer and spiritual guidance. The economic environment, retirement goals, and the individual's risk threshold will also affect this decision. A common decision can involve an infinite number of factors within its system.

By identifying the potential complexity of a simple system, it is easier to appreciate the intricacies of a more elaborate system like the F-22 acquisition process. The F-22 acquisition process is an open system. Included within system boundaries are the contractors and F-22 SPO personnel, the weapon system hardware and software, performance requirements and budget constraints, and numerous other factors. Additionally, many environmental factors affect decisions and outcomes but are outside the system's control. The development of a major weapon system is so elaborate that it takes as long as fifteen years before the first operational aircraft is fielded. This is caused by unique Air Force requirements, the high rate of technology turnover, and the complexity of the aircraft and its subsystems. The decisions made in these areas will affect the consequences for the logistics community once the F-22 is in its operational environment. Therefore, the decisions made concerning aircraft support must be considered during the initial acquisition phases of development and production.

Systems Approach Terminology and Phases. Several terms dealing with the systems approach need to be discussed here. The objective is the purpose or intended function of the system. The objective should be clearly stated and understood to ensure the organization understands what it is trying to

achieve. The objective of the SSIPT is to make wise decisions to ensure efficient and effective supply support for the entire life of the F-22 program. A requirement is a partial need within the total system. The requirement this thesis is attempting to fulfill is to provide guidance for making a decision on the best time to determine the long-term supply support posture for the F-22. An alternative is an available option to accomplish a requirement. The alternatives for this situation include total contractor support, total organic support, or a mixture of support. Additionally, the number of possible alternatives can change depending on when the decision is made. The selection criteria are the factors used to evaluate and choose a preferable alternative. The selection criteria for any project include cost, performance, and schedule. Additional criteria are a subject for discussion and are included in this analysis. Constraints are limitations that are imposed from within the system or by the environment. Constraints can include but are not limited to resources, politics, environmental issues, and marketing results (Kerzner, 1998).

The phases for making a decision are an extension of the terms listed in the previous section. The translation phase evaluates the terms listed above. The analysis phase identifies the alternatives for solving the problem. The trade-off phase applies the criteria and constraints to each option and compares feasible alternatives. The synthesis phase is choosing the best solution (Kerzner, 1998). Table 4 summarizes these decision-making phases.

Table 4. Systems Phases for Decision-Making (Kerzner, 1998).

Phase	Description
Translation	Evaluation of Systems Terminology
Analysis	Identification of Alternatives
Trade-Off	Application of Criteria and Constraints
Synthesis	Selection of Best Solution

<u>**The Project and Project Team**</u>. A project is a relatively short-term effort with specific start and end dates. It has a stated objective and must meet required specifications. A project consumes resources and is subject to constrained funding. A project team generally consists of a project manager and the individual technical and functional experts. The project manager is the boundary agent who controls the transfer of energy, people, materials, money, and information into and out of the system. A project manager's roles relate directly to the two project management functions listed earlier. As a planner, the project manager must define requirements; and as a monitor, the project manager must track, analyze, and adjust. Additionally, the project manager has the responsibility to coordinate and integrate these activities across multiple, functional lines. These responsibilities require strong communication and interpersonal skills. Other prerequisites include familiarity with the operations involved and a general knowledge of the technology being used. Finally, one of the most important aspects of the project manager is that he or she acts as the interface between top level management and functional managers (Kerzner,

1998). Ultimately, despite all the decision-making tools and quantitative data, the project manager must often rely on gut feeling when determining the best course of action. Gut feeling is a combination of judgment and intuition based on an individual's experience and intellect (Caudle, 1998). Figure 11 displays the project manager's role in a project.

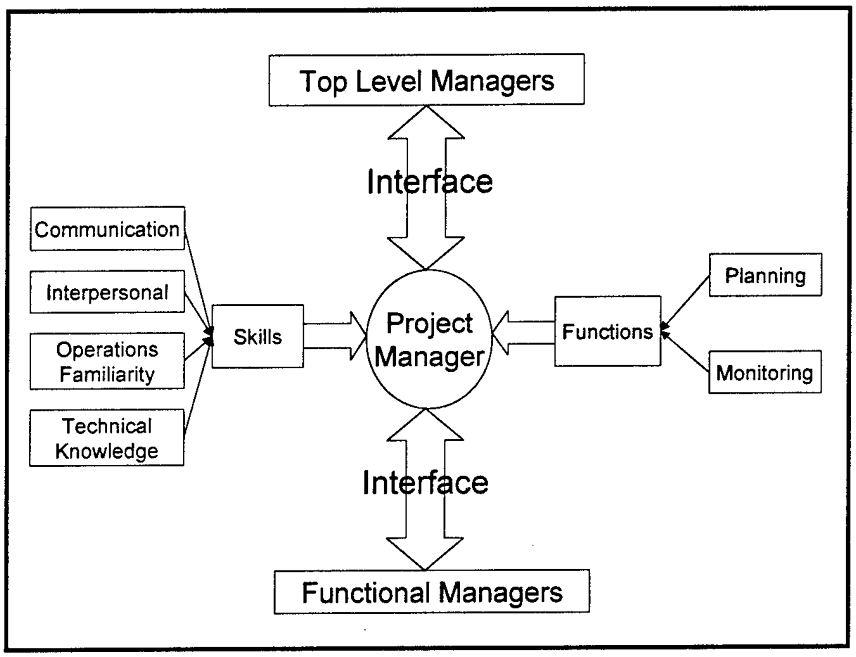

Figure 11. Roles of a Project Manager.

The technical and functional experts may include members from engineering, contracting, legal, marketing, etc. A project team can vary in the size of its members and its budget depending on its importance to the organization. A project is an open system because it has an infinite number of relationships and interactions outside its environment. These interactions include communication from within the organization and from outside the organization. Internal management guides project direction through official policy, project

objectives, and the size of the budget. The end-item user can also be an important source of interaction with the project team. In the case of Air Force weapon system projects, the pilot is the end-item user. Since the project is geared toward making the pilot more effective, project team members must listen to the needs and wants of the pilot community.

Air Force Definitions of a System, Program, and Project. A system is composed of the equipment, skills, and techniques required to perform or support an operational role. It may also include facilities, materials, and personnel. An Air Force system is a self-sufficient unit operating in its intended environment. A program is the first level element of a system. It includes the integrated, time-phased tasks necessary to accomplish a particular purpose. The smallest unit is the project. Projects fall within a program, have a scheduled beginning and end, and involve a primary purpose (Kerzner, 1998).

For the purposes of this research, the system is the Air Force and the program is the entire F-22 program and available resources. The project is the SSIPT and its function to provide effective and efficient life cycle supply support for the F-22. Determining stability and determining when to make long term decisions are sub-elements of the project, and can be considered as projects themselves.

Project Evaluation Criteria. In the project management discipline, a project's success is determined by three criteria: cost, performance, and schedule. Good customer relations are equally important in non-government

organizations because reputation is an important aspect of survival (Kerzner, 1998). The relationship between these criteria is illustrated in Figure 12.

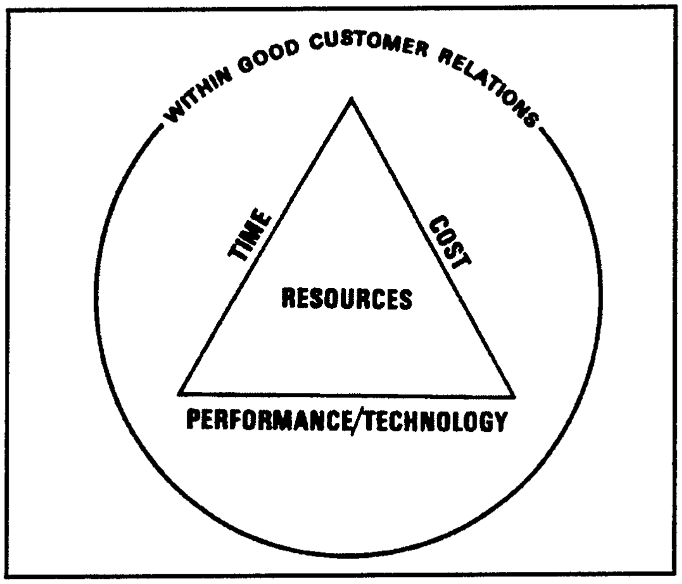

Figure 12. Project Evaluation Criteria (Kerzner, 1998).

The primary goals of a project are to minimize costs, achieve performance objectives, adhere to the projected schedule, and maintain good customer relations. Figure 13 summarizes these goals.

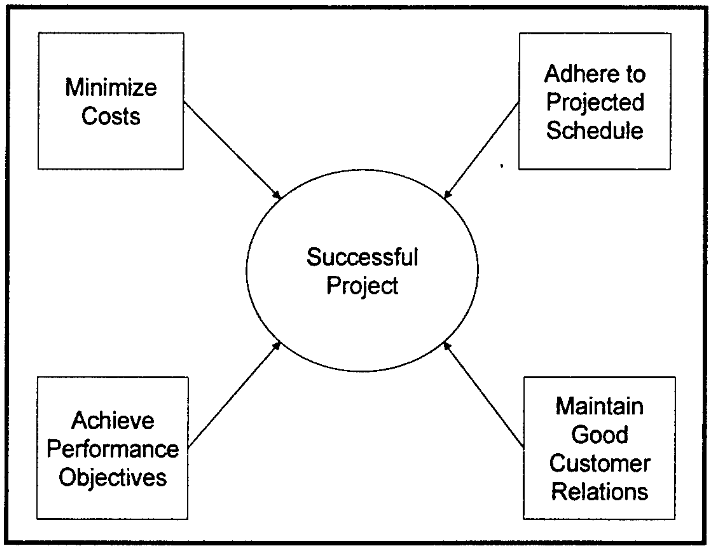

Figure 13. Goals of a Successful Project.

Cost is significant because a project is judged by its adherence to budgetary constraints. Cost is the most significant criteria because of its potential to kill a project and its ability to override the other two criteria. Keeping costs within budget is preferable to running over budget; however, some projects are expected to run over budget. Evaluation in these circumstances may include comparison to past projects or to other projects currently operating within the organization. An example of expectations for cost overrun is the acquisition of new weapon systems in the Air Force. There is a high amount of risk and uncertainty when developing a new weapon system, and this increases the likelihood or expectation of cost overruns. Less cost is better in these cases because it is easier to justify spending taxpayer dollars. Congress holds the purse strings for the military, so it is wise to realize that current success with cost objectives will affect the future availability of funding.

Performance objectives are important because they are the reason why a project was created in the first place. It is senseless to spend time and money on a project and not meet some minimum standards for expected performance. Performance was the primary criterion for evaluating a military acquisition project before the downfall of the Soviet Union. Weapon system requirements result from the MNS and ORD documents, and national security objectives can be compromised when performance targets are not achieved. For this reason, performance is still a major criterion, although cost generally takes precedence today because the perceived threat is less. Performance and cost are competitors because increased performance costs more money. For this reason, a conflict exists between raising performance standards and minimizing costs.

The final criterion is schedule. The schedule is valuable as a planning tool and because it is closely related to cost, thus the phrase "time is money." An organization must be able to accurately predict the availability of its resources and make strategic, tactical, and operational decisions according to the estimated schedule of a project. Also, if a project is over schedule it is likely to be over cost. In a peacetime atmosphere, military schedules usually assume less importance than cost and performance. Schedule is less important because of the relative duration of the delay versus the overall acquisition process. The acquisition process requires up to fifteen years until the first operational aircraft is delivered, and it is not uncommon for schedules to be slipped or delayed a couple of years.

<u>Proposition 1</u>. The first element in the conceptual model is presented following the previous discussion on project management. The F-22 supply support decision-making task is classified as a project. There is a definite beginning and ending to this project. Its inception occurred during the concept exploration phase and it will conclude when the determination is made that the F-22 is mature. Determining when the F-22 is stable will consume a large amount of resources including people, money, materials, technology, and information. Funding is limited by Congress as evidenced by the continual downsizing of the F-22 total aircraft buy, and shifting of resources and responsibilities to future years. A closely related project is the analysis and decisions that result concerning what the supply support posture will be. This project will terminate when the final system or subsystem is analyzed and the decision is made for organic or contractor support. Supply support decisions will continue to amount to a significant portion of the F-22 program until the last F-22 is retired.

Additionally, the project management approach provides a systematic process for performing this task. The cost, performance, and schedule criteria used for evaluation are suitable since the goal is to evaluate cost and performance alternatives to determine the most advantageous schedule for the government. This approach allows decision-makers to look at the total system and determine the best overall course of action, without focusing too narrowly on individual aspects that may mislead or confuse. Based on this analysis, the first proposition is:

- **The process of determining future supply support responsibilities for the F-22 should be treated as a project, and the project management approach should be utilized as the vehicle for performing this process.**

Proposition 2. The second proposition is closely related to the first. A project requires an individual or group to perform the decision-making phases listed in Table 4 (translation, analysis, trade-off, and synthesis). The F-22 SSIPT is already an integral part of the F-22 program. The objective of the SSIPT is to determine the best course to provide supply support over the life cycle of the F-22. This places this integrated team in an ideal position to make supply support decisions. The team is a mixture of government and contractor personnel from a variety of backgrounds. This team has more expertise and knowledge concerning F-22 supply issues than any other. The chairperson for this IPT has the ultimate responsibility of planning, scheduling, directing, and controlling available resources to ensure the best decisions are made. As the project manager for this task, the chairperson requires the widest latitude to execute this responsibility. This discussion leads to the second proposition:

- **The chair or head of the F-22 SSIPT should act as the project manager for this decision making process, with the F-22 SSIPT acting as the project team. The project manager should assume the responsibility and authority necessary to perform this task.**

Defining Stability

Defining stability is a difficult task. The Air Force has arbitrarily established 100,000 flying hours as the operational definition of stability for the

F-22. This definition is conservative since the total number of aircraft has been significantly reduced and the acquisition cycle delayed. These decisions mean that fewer aircraft are being produced over a longer period of time, and consequently, it takes longer to achieve 100,000 flying hours. Another possible definition is the F-22 initial operational capability (IOC). IOC is defined as the first operational fighter squadron, and this event is projected to be achieved in 2005. There is a window of no greater than three years between IOC and 100,000 flying hours if the production schedule is not delayed any further (F-22 ILSS, 1997). According to these criteria, the definition for stability could be the period of time between IOC and 100,000 flying hours. While this time frame may be acceptable to decision-makers, this topic requires further analysis before any final definition is settled upon.

Thoughts on Stability and Maturity. It is possible to draw from personal experience to better understand what stability means. Certain words come to mind--such as consistent, comfortable, predictable, and safe. It is also possible for stability to have an opposite meaning. A routine or system may be predictably unpredictable. An argument could be made to define a predictably unpredictable schedule as being stable. A weapon system may never reach its reliability goals, or its performance may be consistently tumultuous. This does not mean it has not reached stability, because the second part of the stability equation focuses on maturity. Similar thoughts surface concerning maturity. There is not a specific age of maturity, but there are factors to help assess a

system's maturity level. Maturity implies that a task is complete, or that performance is at such a level that there is little room for improvement.

Acquisition Studies. Two studies were commissioned in the mid-1980s to research and evaluate weapon systems and make determinations concerning the length of the acquisition period. RAND studied weapon systems since the 1940s and determined that the acquisition period has lengthened slightly. The period between the Milestone 1 and Milestone 3 is the main cause of the lengthened acquisition duration (Rothman, 1987). Milestone 1 is the decision to enter Program Definition and Risk Reduction, and Milestone 3 is the decision to enter full-scale development. This period covers the majority of decisions concerning a weapon system. Therefore, it makes sense that this period would be the major cause for lengthening the acquisition cycle.

The other study was accomplished by Air Force Systems Command (AFSC) in 1983. This was the largest research effort on the acquisition process, covering more than 600 prior studies and reports, and 109 past Air Force weapon systems. One of the principal findings was that the Air Force has experienced significant increases in the development cycle of new weapon systems. There have also been significant decreases in the annual production rates. Lastly, gains in performance have resulted in increased procurement costs. Program instability was the primary cause of cost and schedule growth. Program instability is defined as large unplanned changes to funding or the schedule. Three interdependent problems were listed as the cause for program instability: funding instability, requirements instability, and technical problems.

The eventual outcome was that less equipment was bought than could have been purchased with the same amount of money (AFSC, 1983).

Since instability was defined as large unplanned changes, then stability can be defined as closely adhering to initial plans. The comparison of two acquisition processes will show the specific results of a stable acquisition process. The B-1 program is a suitable example of program instability. This program began in 1967 and was given production approval in 1976. It was terminated in 1977 and re-approved in 1981. Compared to historical bomber acquisition cycles for the B-52 and B-58, the B-1 took longer to develop and had lower average production rates (AFSC, 1983). This program violated all three of the interdependent causes for program instability (funding, requirements, and technical).

The F-16 is an acquisition success story. Multi-national interests in this weapon system led to increased program stability. Also, concurrent development with the F-15 allowed the program to proceed with no major technical problems. The only advanced technology required was the fly-by-wire system. The plan was executed close to cost and schedule estimates, and a potential $1.3 billion was saved by not stretching the length of production for 725 aircraft (AFSC, 1983).

Additional consequences have resulted from program stability, or instability, during the acquisition cycles of these two weapon systems. The F-16 is currently one of the most reliable weapon systems in the Air Force inventory. The F-16 mission capable goal of 85 percent has been consistently exceeded,

while the B-1 has struggled during this same period to reach a 70 percent mission capable rate in 1996 (ACC, 1996). Stability is important throughout the life cycle of an aircraft. Lack of funding for spare parts for both weapon systems has resulted in distinct decreases in performance during the past two years. This insufficient funding comes at a time when spare parts are increasingly critical due to increased weapon system breaks caused by wear and tear on 15-year-old aircraft. These lessons can be applied to the definition of stability for this research effort.

Proposition 3. Another element of this evolving model is stability. Operational stability is a major input to the determination of when to make life cycle supply support decisions for the F-22. A definition of stability is attained by integrating the thoughts on stability and maturity with the Rand and AFSC findings. F-22 stability will be achieved when aircraft performance is consistent, meaning there is low variance in the reliability factors. These factors include aircraft availability rates, and non-mission capable percentages for maintenance and supply. Consistent performance will enable decision-makers to predict future results within comfortable limits, only if current plans remain relatively unchanged. The F-22 will be stable when it is no longer immature, but complete and sound. Maturity implies the weapon system is able to perform its intended mission; however, maturity is possible even with lower than expected reliability rates. Lower reliability results in lower availability, which means an individual aircraft may be capable but the F-22 fleet does not meet the standard. Because "up-front design is essential to achieving a reliable product" (Criscimagna, 1997),

it is possible that unknown environmental factors will affect F-22 reliability. Not every environmental factor can be considered during the design phase because of the unique characteristics of the F-22. These factors may make it impossible to reach the 85 percent mission capable requirement; however, poor performance does not mean that the weapon system has not reached a stable level of performance. Again, the key is consistency. Figure 14 displays a bathtub curve that summarizes the historical relationship between the life cycle (x-axis) and failure rates (y-axis). Failure rates decrease during the infancy period, bottom out and stabilize during the maturity phase, and finally increase as the weapon system reaches retirement.

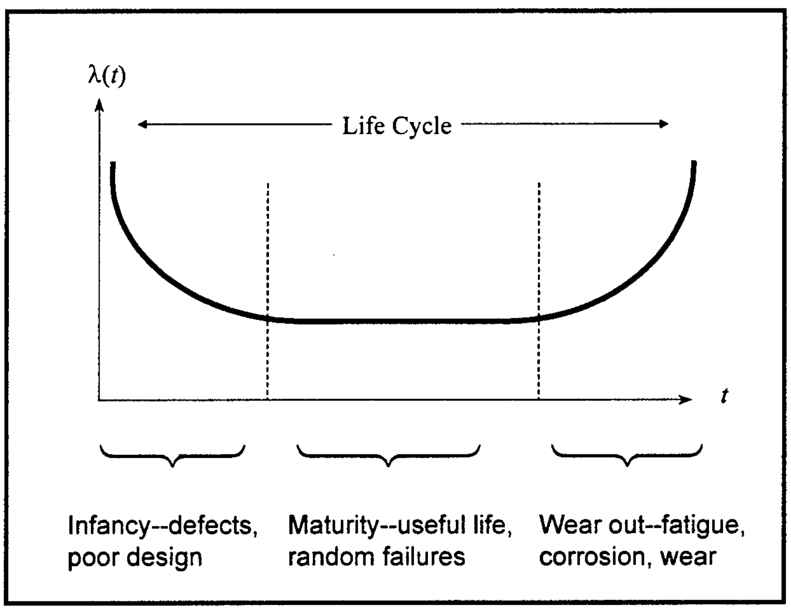

Figure 14. Bathtub Curve (Johnson, 1998).

The difficulty is knowing when stability has arrived. The only sure way to determine that a weapon system has reached this milestone is to examine it in retrospect. The impossible question to accurately resolve is "where is the F-22

on the bathtub curve?" Much of this responsibility rests on the shoulders of the SSIPT chairperson, or project manager. In fulfilling this responsibility, the program or project manager must be "counselor, engineer, designer, historian, accountant, logistician, administrator, strategist, planner, and commander," as well as "student" (Cleland, 1993). This analysis leads to proposition 3:

- **Operational stability will be achieved when the F-22 SSIPT is comfortable with the consistent performance of the weapon system, as evidenced by low variability in the reliability factors. Stability will be potentially influenced by unplanned changes in funding, requirements, and technology.**

Evaluation by System/Subsystem. The current strategy is for the F-22 SPO to evaluate the F-22 system-by-system to achieve economies of scale. It would not make sense to evaluate each part individually because systems consist of primarily similar parts. Because the system parts are similar, the repair processes are likely to be similar. For this reason, it makes good fiscal sense to analyze cost, performance, and schedule factors for the entire system or subsystem. It is important to note that these factors should be predicted for the entire life cycle and beyond. Most Air Force weapon systems outlive their predicted life cycle. A good example is the B-52, which is more than 40 years old. Likewise, the F-15 is now projected to 'fly, fight, and win' through 2020. It is too costly in terms of time and money to retire a weapon system that is still adequately performing its mission. A much cheaper alternative is to modify and overhaul an existing weapon system. This trend is likely to continue in this constrained resource environment.

Limiting the Role of Reliability. "Probability and statistical inference are the way we structure and quantify our ignorance." This comment was made in reference to the improper use of quantitative tools by many reliability professionals. An example is the improper application of the Duane Growth Curve. Duane's tool is designed to "estimate test time to grow reliability to its mature value." It is applied by starting at ten percent of the desired mature reliability and drawing a line with slope between .1 and .5 until the desired value is reached. The problem is that this tool is only a rule of thumb based on empirical observations; there are no underlying mathematical bases for Duane's Growth Curve (Meth, 1994). This point is made with the hope that decision-makers will not overly emphasize reliability and statistics. System reliability is an important parameter to consider when determining the supply support posture, but it is not the only factor.

"The prediction of reliability for systems of electronic components is at best an art" (Pecht, 1994). This is a powerful statement for the F-22, which is definitely a system filled with electronic components. Predicting reliability is an art because it is impossible to narrow the prediction to an equation or a bunch of numbers. It cannot be taught or learned like a science. Many designers and manufacturers are realizing this and are questioning the role of prediction methods in reliability programs. Additionally, many government standards are not suited for acquisition applications. "The techniques used in estimating reliability and making trade decisions are only remotely related to the factors that ultimately determine field reliability today. Better tools are desperately needed to

analyze the reliability of new designs" (Pecht, 1994). For these reasons, the DOD has identified many reliability, maintainability, and supportability standards that are barriers to commercial processes. These barriers are also major cost drivers. Consequently, the DOD is pushing for standardization and partnerships with industry associations (Caroli & Gorniak, 1997). Finally, Rand studies have shown that modeling and simulation exercises are an "abstraction from reality" because the "ultimate proof requires real-world implementation" (Rand, 1996).

Proposition 4. This proposition is an element of the proposed model that recognizes the limitations of current tools in determining stability. These limitations also apply to the system/subsystem level. Because there are many unknowns, it is necessary to begin the evaluation process as soon as possible. Creating a stable process is important for establishing continuity. Continuity will foster a spirit of teamwork and make use of lessons learned along the way. This process must continue despite changes to the F-22 acquisition plan or political decisions. The AFSC and Rand studies discussed earlier found that program instability (large unplanned changes in funding/ schedule) is the major source of cost and schedule growth in the acquisition cycle. The result has been fewer aircraft bought than could have been with the same amount of money (AFSC, 1983). This same lesson can be applied to this project. Immediate implementation of a continuous evaluation process will reap benefits for the F-22 program and the Air Force over the long run.

- **The F-22 SSIPT should begin the evaluation process immediately. This will allow team members to build a knowledge and experience base, and to clarify the process and criteria as more credible data are available and the future is more clearly understood. Also, the IPT should continuously evaluate the process model and its elements, as well as the accompanying input data.**

Other Evaluation Considerations

There are factors other than stability that should be considered when making long term decisions about the future of F-22 supply support. Managing risk and performing trade-off analysis should be woven throughout this process. Additional considerations affect the decision of when to determine the best supply support mixture, as well as the decision determining the ultimate balance of contractor-organic responsibilities. These considerations are contract provisions, the transition plan, infrastructure and training, spare parts and storage, and future sustainment beyond the projected life cycle.

Risk Management. The importance of managing risk applies to every aspect in this analysis. Risk should be an integral element of project management, not a distinct and independent function. "Risk is defined as the probability of an undesirable event occurring and the significance of the consequence of the occurrence" (Defense Systems Management College, 1989). In this case an undesirable event is categorized as "not achieving a defined project goal" (Kerzner, 1998). The project goals are to determine when to decide the supply support posture, and what that posture should be. The inherent risk in

these decisions includes poor forecasting of organic versus contractor costs and capabilities, inaccurate data from the contractor, and faulty projections.

It is important to distinguish between "known unknowns" and "unknown unknowns." "Unknown unknowns" fall under the category of uncertainty because probabilities are nonexistent. In this case, only qualitative assessments are possible. Risk is the "known unknown" because probabilities of occurrence can be assigned (Kerzner, 1998). Unfortunately, even with risk there is a high degree of subjectivity (Defense Systems Management College, 1989). If ten experts were asked to rate the risk of several categories there would probably be ten different assessments. It is appropriate to say that there are aspects of science and art in the risk management discipline. The science portion of risk management is the methodology used to continually address the facets of risk throughout the life of a project.

Risk management methodology includes four related actions. The first action is risk identification. This action includes identifying and classifying potential risk. The next action is to quantify risk by determining the probability of occurrence and the associated consequences. There are many available tools to aid in the analysis and discover the cause, effects, and magnitude of perceived risk. This action also includes developing alternative options. Risk response is an attempt to reduce or control the risk. The final step is risk control or lessons learned. Documenting lessons learned is important because it benefits future decision-makers (Kerzner, 1998). Table 5 summarizes the four actions of risk management methodology.

Table 5. Risk Methodology Actions.

Risk Action	Description
Risk Identification	Identify & classify risk
Risk Quantification	Quantify risk & develop options
Risk Response	Reduce & control risk
Risk Control or Lessons Learned	Document lessons learned

The five facets of risk are technical, programmatic, supportability, cost, and schedule. Classifying risk into one of these categories is important because it helps to understand the source and impact areas, and it provides a structure to examine and manage risk effectively. It is possible that a risk area can fall into more than one facet. Technical risk deals with creating a higher level of performance than previous designs. Programmatic risks involve activities outside the system's control. This includes decisions made at higher levels of authority, and the inability to foresee problems. Supportability risk occurs with maintaining systems in the operational field, and cost and schedule risk are concerned cost and schedule growth as the project progresses through its life cycle. These facets and their interrelationships are shown in Figure 15. Notice that technical, programmatic, and supportability affect cost and schedule.

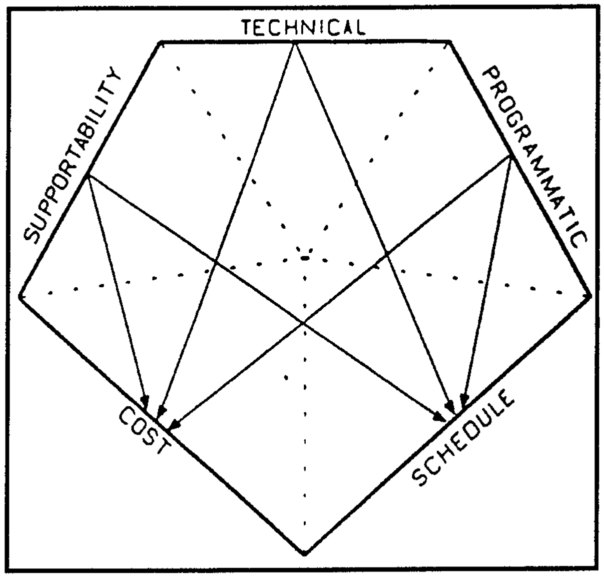

Figure 15. Relationship Between Risk Facets (Defense Systems Management College,1989).

An important aspect of risk management is the emphasis on continuous analysis. The Software Engineering Institute (SEI) defines risk management as a proactive environment of continuous assessment of risk, determining what is important, and implementing appropriate strategies. "Risks are assessed continuously and used for decision making in all phases of a project" and "are carried forward and dealt with until they are resolved" (Higuera et al., 1994). Figure 16 displays this continuous process throughout the product life cycle. This figure appropriately describes the emerging design philosophy of this entire project, not just risk management. Data are continuously analyzed throughout the life cycle, and re-analyzed as data change and the environment affects the process.

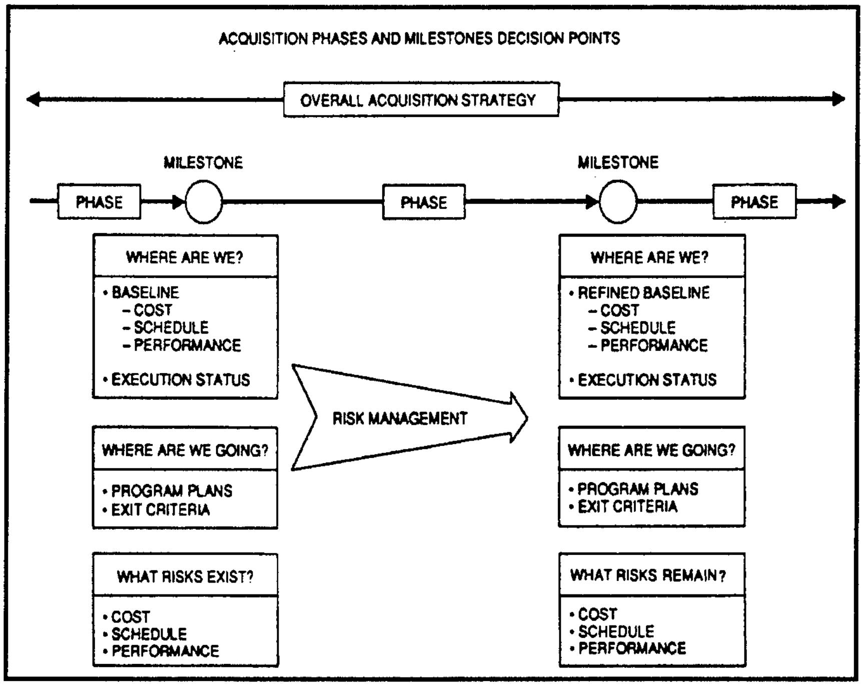

Figure 16. Risk Management Cycle (Cleland et al., 1993).

Trade-off Analysis. Risk is an integral tool for clarifying available options and trade-off analysis is the means for comparing and contrasting those options. Trade-off analysis is the third phase of decision-making. It falls under the umbrella of the systems approach because it employs the idea that the smallest change in a project has the potential to affect all of an organization's systems (Kerzner, 1998). This concept applies to the F-22 because a change to the maintenance concept would affect supply support and vice versa. The interrelationships are so intertwined that changes will usually produce a reciprocal consequence in another system.

Trade-off decisions are important because there is not usually one best option. If the primary constraint in an automobile purchase decision is cost, then the decision may be simplified if the budget for this purchase is limited to

$12,000. The decision becomes more complicated as the options increase, such as when cost, performance, and schedule are weighed equally. For example, there are numerous alternatives if the budget is $20,000 and the buyer wants a four-door sport sedan. The Air Force wants the most efficient and effective weapon system in the shortest period of time. Balancing F-22 cost and performance criteria requires tough choices to manage conflicting objectives. The F-22 SSIPT will experience similar choices when determining stability, and in the eventual decision concerning the supply support posture. One of the project manager's greatest contributions is to provide stability when adverse conditions occur (Kerzner, 1998). The project manager must keep a cool head and be capable of resolving differences of opinion or making the tough decision.

<u>Other Parameters</u>. Additional considerations for this decision are contract provisions, the transition plan, infrastructure and training, spares and storage, and future sustainment beyond the F-22's projected life cycle. Contract provisions may dictate when the contract can be cancelled and organic capabilities shifted to the Air Force. These provisions could also make it more cost effective to accelerate or delay this process. The transition plan is required by the Air Force (AFMC RSSP, 1996). This plan is a consideration for when the supply support posture decision should be made because its details may affect cost, schedule, and performance. The impact on these criteria depends on the state of the economy, the size and budget of the military, the condition of the contractor, and many other environmental issues.

This same timing argument should be applied to infrastructure and spares. Decision-makers should consider the Air Force infrastructure that would be required to sustain an organic supply support capability. Are these resources currently available? What training will be required? What about the number of spares needed and the storage facilities required? These issues will have a greater impact on the decision of what the final supply support mixture should be, but they also affect the determination of when this decision should be made.

The possibility of sustainment beyond the F-22's projected life cycle may present one of the greatest impacts to this decision. The high turnover rate in technology creates parts obsolescence and makes it difficult to find support for the Air Force's unique requirements. The corporate world is profit oriented because profits are required to stay in business over the long run. This may impact the future ability of the contractor to provide supply support for the F-22.

Proposition 5. This proposition summarizes the inputs described previously. Cost, performance, and schedule criteria are included to reemphasize their importance in the project management discipline. Trade-off analysis recognizes the conflicting nature of the cost, performance, and schedule criteria. Risk management stresses the significance of the unknown. The probability of occurrence must be assessed to these unknowns to allow for credible predictions. The remaining parameters are inputs to the decision-making process. Potential parameters are not limited to those mentioned here because so little is currently known about this subject, and more information may surface as time passes. Proposition 5 lists the parameters for this model:

- **Parameters for the F-22 supply support decision should include (but are not limited to):**

  ⇒ **cost, performance, and schedule data**
  ⇒ **risk management and trade-off analysis**
  ⇒ **contract provisions**
  ⇒ **reliability data**
  ⇒ **contractor performance**
  ⇒ **operational stability**
  ⇒ **the transition plan**
  ⇒ **infrastructure and training**
  ⇒ **spares acquisition and storage**
  ⇒ **sustainment beyond the weapon system's projected life cycle**

Proposition 6. This final proposition is included because there is as much art as science in this process. The definition of project management is that it is an art (Kerzner, 1998). An experienced team is essential for making decisions based on more than just fact. This point is made in Figure 17. Judgment, intuition, and gut feel are listed as determinants in this decision-making process (Caudle, 1998). Systems theory requires an evaluation of the total picture versus individual components (Kerzner, 1998). There are quantitative tools available at the component levels, but there are no system tools available to evaluate this entire process. While more facts may turn up as the process evolves, some portion of these supply support decisions will remain art.

- **Judgment, intuition, and gut feeling will be a major factor in the ultimate F-22 supply support decision.**

Building the Model

This conceptual model is created by integrating the six propositions suggested in this analysis. Figure 17 presents these propositions and their inter-relationships.

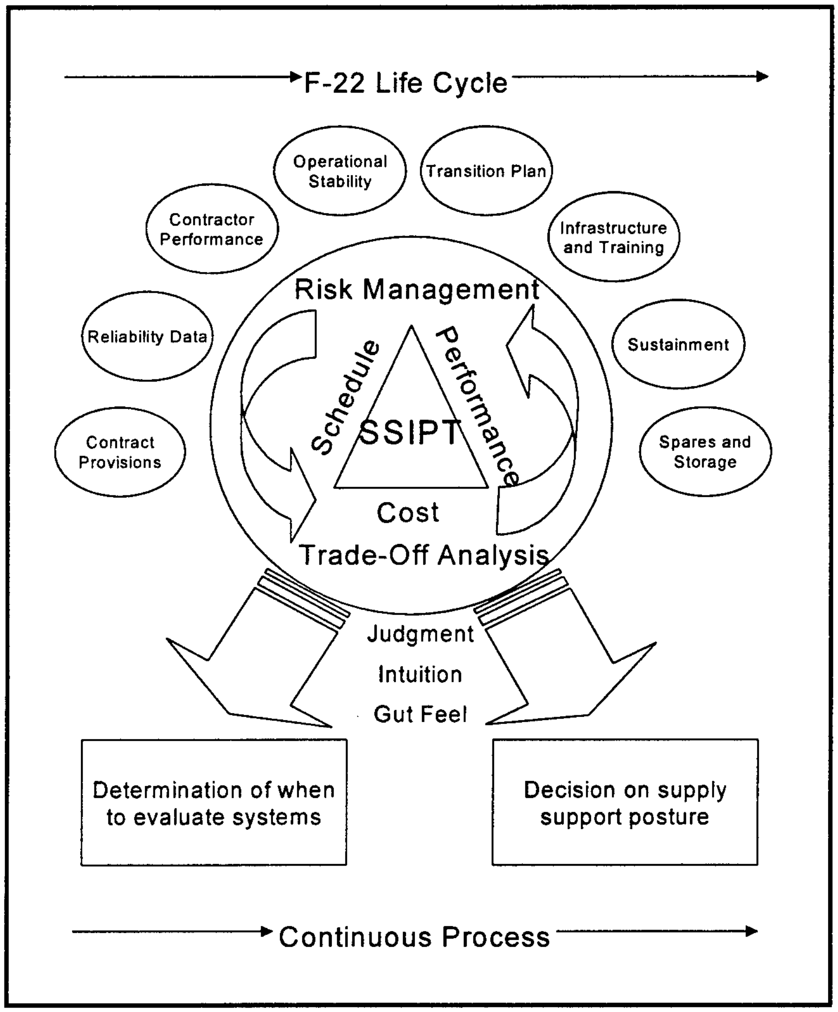

Figure 17. Conceptual Model of the Supply Support Decision Process.

The eight circles around the top of the model depict the data inputs for the decision-making process. These were highlighted in proposition 5. The SSIPT is in the center of the triangle because they represent the project manager function

that is responsible for this project. This concept was explored in propositions 1 and 2. Around the triangle are the cost, performance, and schedule criteria that must be satisfied to complete a successful project. Encircling the triangle are the risk management and trade-off analysis functions. The arrows illustrate that these functions are not separate elements, but are an integral part of the analysis and decision process. These parameters are also listed in proposition 5. Judgment, intuition, and gut feel are included at the bottom as part of the final decision. Proposition 6 describes the rational for their inclusion as a major factor in this process.

A substantial aspect of the model in Figure 17 is that the two decisions (when to make the decision and what the decision will be) are born of the same process and essentially the same inputs. The decision on supply support posture is included for this reason, even thought it is not the subject of this thesis. Another important matter is that evaluation should be a continuous process as the F-22 life cycle progresses. This concept is addressed in proposition 4. The arrows proceeding from left to right at the top and bottom of the model are included to illustrate this point. It is likely that these decisions will not be made once and for all. The outsourcing atmosphere that current acquisitions are subject to may not prove to meet Air Force needs in the long run. Some form of the F-22 SSIPT should be in place to address these concerns as this atmosphere changes.

Summary

This chapter developed a series of propositions that suggest possible elements of inclusion to the F-22 supply support decision-making process. These propositions were integrated to create a conceptual model that displays the process and the relationship between the parameters, the decision-making authority and its constraints, and the final decision. This analysis is not the final ruling on this topic, but should prove a useful foundation to build upon. This investigation lays the foundation in the hope that it will be a catalyst for future research efforts.

V. Conclusions and Recommendations

Introduction

This research explored the evolving Air Force acquisition and support philosophy for the F-22 and future major weapon systems using the interim contractor support (ICS) philosophy. ICS plays a large initial role in this new philosophy because organic capabilities are shrinking with the size of the Air Force. The need for a definition of weapon system stability was introduced in Chapter I. This definition is necessary to determine when an aircraft has reached a mature level to allow analysis of the best means for continued supply support throughout the weapon system's life cycle. The literature review in Chapter II addressed current Air Force guidance on the topic of stability. The need for stability at various points throughout the acquisition process is referenced from numerous documents; however, a clear definition of stability is never given. Chapter III developed the qualitative methodology used to study this topic. The analysis and findings were presented in Chapter IV. The focus of the analysis was centered in the project management approach to problem solving. The recommendations are discussed in more detail later in this chapter.

Problem Statement and Research Questions

- **There is no clear definition of weapon system stability to make life cycle support decisions for the F-22.**

This problem statement results from the management question asking "what is the best mixture of supply support for the F-22 that optimizes efficiency and effectiveness?" To know the best mixture, one must first know when the topic

can be practically addressed to be able to make this determination. Therefore, the research question for this study was:

- **When is the weapon system stable/mature enough to make this decision?**

This research question produced several investigative questions listed below:

- **What process should be used answer the research question?**
- **Who should be the decision authority for this process?**
- **What parameters should be used to define this process?**
- **What is the definition of weapon system stability?**
-

Finally, the thesis objective was developed as a result of the questions listed above.

- **This thesis will develop a conceptual model that describes the decision-making process that should be used to determine when to evaluate the optimum life cycle supply support posture for the F-22.**

<u>Overview of Propositions and Conceptual Model</u>

The scope of this research was not intended to determine what the ultimate supply support posture should look like. Instead, six propositions were suggested and these propositions were integrated to develop a conceptual model that serves as a framework for the decision-making process. The decision-making process emerged as the central theme of this research since there are limited data available for validation. The initial conceptual model of this process (shown again in Figure 18) included the idea that a stable weapon system design is the driving factor for determining the timeframe for making life cycle supply support decisions.

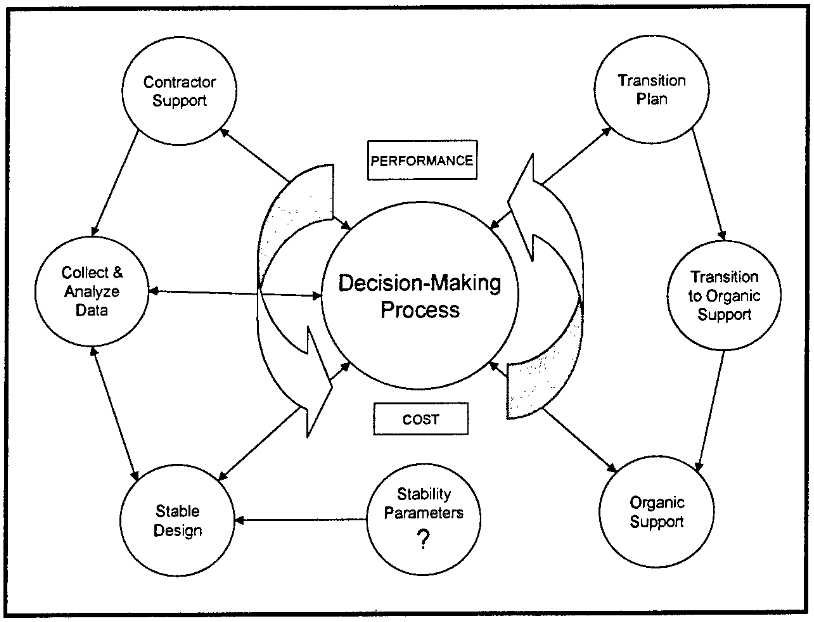

Figure 18. Initial F-22 Supply Support Process Model.

This model provided a good starting point for this research but it soon proved inadequate because it does not accurately describe this process. A conceptual model evolved as a result of the analysis accomplished in Chapter IV. This model emerged as the researcher recommended a series of six propositions. These propositions are listed below:

- **Proposition 1:** The process of determining future supply support responsibilities for the F-22 should be treated as a project, and the project management approach should be utilized as the vehicle for performing this process.

- **Proposition 2:** The chair or head of the F-22 SSIPT should act as the project manager for this decision-making process, with the F-22 SSIPT acting as the project team. The project manager should assume the responsibility and authority necessary to perform this task.

- **Proposition 3:** Operational stability will be achieved when the F-22 SSIPT is comfortable with the consistent performance of the weapon system, as evidenced by low variability in the reliability factors. Stability will be potentially influenced by unplanned changes in funding, requirements, and technology.

- **Proposition 4:** The F-22 SSIPT should begin the evaluation process immediately. This will allow team members to build a knowledge and experience base, and to clarify the process and criteria as more credible data are available and the future is more clearly understood. Also, the IPT should continuously evaluate the process model and its elements, as well as the accompanying input data.

- **Proposition 5:** Parameters for the F-22 supply support decision should include (but are not limited to):
  - ⇒ system/subsystem stability
  - ⇒ risk management and trade-off analysis
  - ⇒ cost, performance, and schedule data
  - ⇒ contract provisions
  - ⇒ reliability data
  - ⇒ contractor performance
  - ⇒ the transition plan
  - ⇒ infrastructure and training
  - ⇒ spares acquisition and storage
  - ⇒ sustainment beyond the weapon system's projected life cycle

- **Proposition 6:** Judgment, intuition, and gut feeling will be a major factor in the ultimate F-22 supply support decision.

These propositions were integrated into a model that is displayed in Figure 19. A description of this procedure is included in Chapter IV. The basic concept is that the F-22 SSIPT will act as the project manager for supply support decisions and will evaluate options according to cost, performance, and schedule data. Data inputs to this process are portrayed by the eight circles around the top and sides of the model. Risk management and trade-off analysis are integral elements of this process; however, judgement will play an important role in the final decision due to the limited availability of system tools. Finally, the SSIPT should perform analysis continuously as the F-22 life cycle progresses. It is important to note that modifying or deleting any of the propositions will change this model.

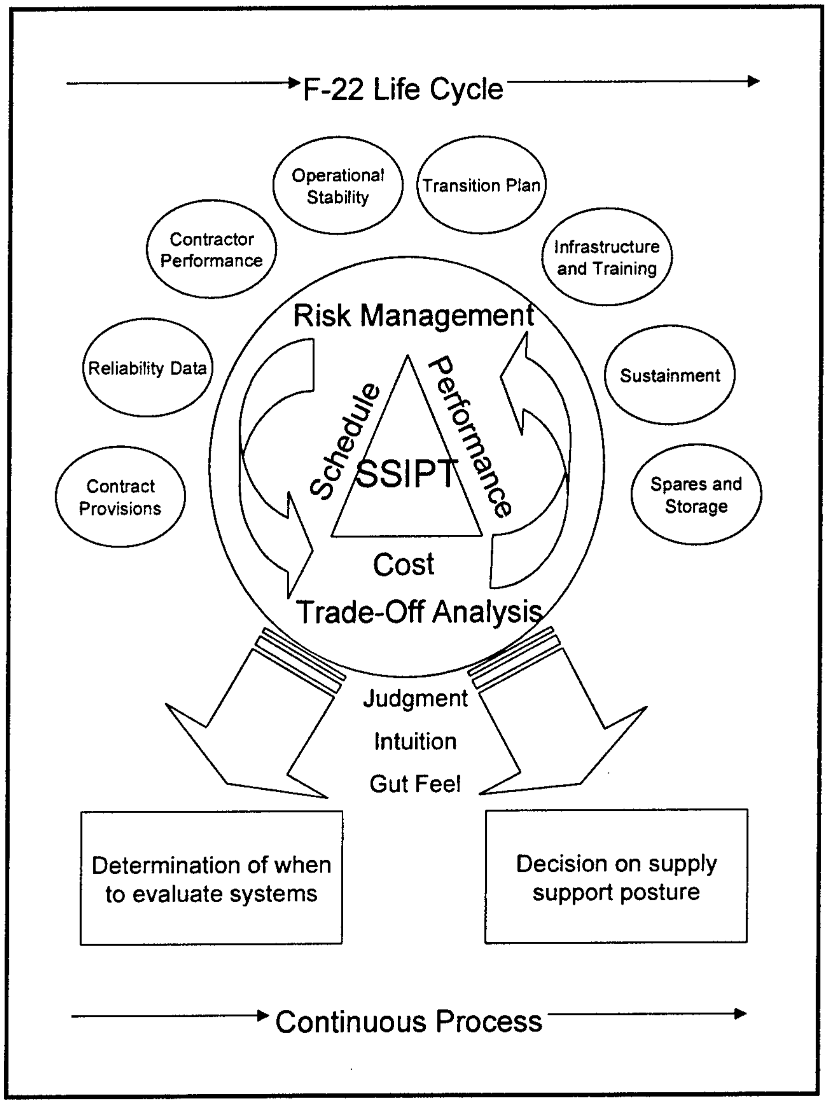

Figure 19. Conceptual Model of the Supply Support Decision Process.

Recommendations

The first recommendation of this research is to begin the F-22 supply support decision-making process immediately. This recommendation is described in proposition 4. This is a better option than projecting a schedule for evaluation and hoping the schedule is accurate. Beginning now will create an opportunity to increase knowledge over time, and will also benefit the decision

concerning what F-22 supply support will ultimately look like. This two-fold benefit is possible because both decisions utilize much of the same information. Therefore, the process of gathering data to answer the first question will also benefit the second.

The second recommendation is to use a project management approach for solving this problem, and to use the F-22 SSIPT as the project team. This recommendation is described in propositions 1 and 2. The F-22 SSIPT is a team of military and contractor experts who are already in place. This integrated product team is in the best position to evaluate F-22 supply support issues.

The third recommendation is to use the parameters listed in propositions 5 and 6 as minimum evaluation requirements for this decision. These parameters are displayed in the conceptual model presented in Figure 19. Judgment, intuition, and gut feeling are part of this process, and may be the decisive decision factors.

The final recommendation is that F-22 stability should be defined as consistent weapon system performance. This recommendation is described in propositions 3 and 6. This is a difficult determination, but low variability in the weapon system reliability factors will be the primary factor defining consistency. Again, intuition of the F-22 SSIPT will play a large role in this determination.

Limitations and Future Research

This investigation was limited by an absence of data concerning past weapon system stability evaluations. These evaluations were not required before interim contractor support (ICS) became the Air Force's first option,

because there was no need for this data. Lack of data also caused the second limitation, which is that this is an exclusively qualitative effort. Consequently, these research findings are general in nature, leaving many details for future research. Finally, the conceptual model has not been validated. There are few opportunities for validation because the acquisition of new weapon systems occurs so infrequently, and the ICS concept may change before the next acquisition. Complementary research should be accomplished to validate this conceptual model and provide more details for this process.

Conclusion

This research was accomplished on a new and emerging topic, and is useful for establishing a starting point for evaluation of DOD supply support issues for new weapon system acquisitions. The conceptual model includes the current parameters that are expected to affect this subject, but these may be incomplete due to the novelty of the ICS concept. The most important finding is that the process for making F-22 supply support decisions should begin now. This will allow an invaluable period of time to gain wisdom and understanding of how to optimize the supply support posture for the F-22.

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Vita

Captain Steven P. James was born on 27 November 1967 in Keokuk, Iowa. He graduated from Keokuk Senior High School in 1986 and received a Bachelor of Science degree from the United States Air Force Academy in 1990. Upon graduation, he was commissioned as a Second Lieutenant and sent to Tyndall Air Force Base, Florida.

Captain James began his first assignment as an aircraft maintenance officer in the 325th Fighter Wing. His duty titles included: Officer-in-Charge (OIC), Avionics Branch; Support Branch OIC, 2nd Fighter Squadron; Generation Branch OIC, 95th Fighter Squadron; and Chief of Maintenance Operations, 325th Operations Support Squadron. His first permanent change of station was to Randolph Air Force Base, Texas in 1995 to assume responsibilities as Chief, Fighter Aircraft Section at Headquarters Air Education and Training Command. Captain James was selected to attend the Air Force Institute of Technology in 1997. He completed the program and was awarded the Master of Science degree in Acquisition Logistics Management in 1998. His follow-on assignment is to the F-22 System Program Office at Wright-Patterson Air Force Base, Ohio.

Captain James is married to the former Kimberly Nicole Cox of Colorado Springs, Colorado. They have two daughters, Madeleine Paige and Lauren Grace.

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11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for public release; distribution unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT (*Maximum 200 Words)*

The Air Force requires a method to determine the most effective and efficient means of supply support for new weapon system acquisitions. This study is a qualitative research effort that examines this requirement in an environment that embraces interim contractor support for the F-22. A series of six propositions are suggested to incorporate in the supply support decision-making process. A conceptual model is developed from these propositions to describe the process for determining the optimal timeframe for making long term supply support decisions. A systems approach to project management is used as the vehicle for this process, and the F-22 Supply Support Integrated Product Team is the driver. Weapon system stability/maturity is contemplated as one of the input parameters, and a definition of stability is presented. Judgment will be a major factor in the ultimate supply support decision due to the lack of available system tools to accurately predict the most appropriate timeframe. The most important recommendation is that the process of evaluation should begin immediately. Familiarity will increase knowledge and experience as team members are exposed to this emerging concept. Due to the novelty of this topic, this research documents the deficiency in this area and lays a cornerstone for future research.

14. Subject Terms

Stability, Maturity, Contractor Support, Interim Contractor Support, Supply Support, F-22, Life Cycle Decision Process.

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